REPORT

ON THE

IMPERIAL BUREAU
6 DEC. 1930
OF MYCOLOGY

DEPARTMENT

OF

SCIENCE AND AGRICULTURE

BARBADOS

FOR THE YEAR

1929-30.

ADVOCATE CO., LTD.,

Printers and Book-binders to the Government of Barbados.

1930

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BOARD OF AGRICULTURE,

DEPARTMENT OF AGRICULTURE,

BARBADOS,

July 31, 1930.

Sir,

I have the honour, by direction of the Board of Agriculture, to transmit the Report on the Department of Science and Agriculture for the financial year 1929-30.

2. I trust that it may be possible to print and publish this Report at an early date.

I have the honour to be,

Sir,

Your most obedient servant,

G. C. MAHON,

Acting Chairman of the Board of Agriculture.

The Honourable,
The Colonial Secretary,
Public Buildings.

No. 829.

DEPARTMENT OF AGRICULTURE,

BARBADOS,

July 28, 1930.

Sir,

I have the honour to submit to the Board of Agriculture a Report on the work of the Department of Science and Agriculture for the year 1929-30.

I have the honour to be,

Sir,

Your most obedient servant,

R. W. R. MILLER,

Director of Science and Agriculture.

G. C. MAHON, Esq., M.C.P.,
Acting Chairman of the Board of Agriculture.

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Chapter I.

REPORT OF THE DIRECTOR OF SCIENCE AND AGRICULTURE.

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Chapter I.

REPORT OF DIRECTOR OF SCIENCE AND AGRICULTURE.

SECTION I. STAFF.

Director of Science and Agriculture	R. W. R. Miller, B.A., (Camb.), A.I.C., Dip. Agric. (Cantab).
Assistant Director	C. C. Skeete, B.A., (Cantab.).
Geneticist	A. E. S. McIntosh, B.Sc., Ph.D. (Edin.).
Agricultural Chemist	S. J. Saint, B.Sc., (London), A.I.C.
Assistant to Professor of Chemistry	T. A. E. Barker, B.Sc., (London).
Lecturer in Natural and Agricultural Sciences	Vacant.
Entomologist	R. W. E. Tucker, M.A. (Cantab.), B.Ed. (Capetown).
Veterinary Officer	A. E. C. Goodman, D.V.S. (Acting).
Chief Analytical Assistant	C. A. Coppin, B.A. Sc. (Toronto).
Plant Diseases Inspector	D. R. D. Wiles, D.I.C.T.A.
Chief Clerk	H. O. Ramsey.
Second Clerk	G. D. Ramsey.
Third Clerk	C. G. Humphrey.
Fourth Clerk	B. G. Barrow.
First Field Assistant	C. B. Foster.
Second Field Assistant	Vacant.
Third Field Assistant	S. H. Evelyn, D.I.C.T.A.
Fourth Field Assistant	H. E. Ward.
Analytical Assistant	H. A. Jones.
„ „	C. St. A. Alleyne.
„ „	L. A. Hall.
Botanical Assistant	C. C. Corbin.
Foreman in Charge of Nurseries ..	S. A. Eastmond.

Mr. R. W. R. Miller, B.A., (Camb.), A.I.C., Dip. Agric. (Cantab.) was appointed Director on October 5, 1929 and assumed duties on October 17, 1929.

Mr. C. C. Skeete was granted four months vacation leave from May 24.

Mr. J. H. Robinson resigned on September 20, 1929, and the post of Lecturer in Natural and Agricultural Sciences remained vacant throughout the remainder of the year.

Mr. R. W. E. Tucker was granted three months vacation leave from February 19 in order to enable him to proceed to America for medical treatment. He resumed duty on May 1.

Mr. R. W. E. Tucker was also granted duty leave to attend the Third Imperial Entomological Conference in London which was scheduled to take place in June. He sailed from Barbados on May 24 and returned on July 25.

Lt. Col. H. Greenfield, Veterinary Officer, was granted thirteen days sick leave during March and three months from April 24, and Dr. A. E. C. Goodman was appointed to act for him.

Mr. B. G. Barrow, who was appointed Fourth Clerk on June 1, succeeded Miss V. H. Roach who resigned on May 31.

Mr. C. B. Foster was appointed First Field Assistant on January 1, 1930.

Mr. J. N. W. Niccolls resigned on April 26, 1929, and Mr. H. E. Ward was appointed in his place on June 17, 1929.

SECTION II.—BOARD OF AGRICULTURE.

The members of the Board of Agriculture, appointed for the Legislative Session 1929-30, were as follows:—

Lt. Col. The Honourable Sir F. J. Clarke, B.A., K.C.M.G., M.C.P., Chairman.
The Honourable G. L. Pile, B.A., M.L.C.
" " E. A. Hinkson, M.B.E., M.L.C.
" " W. B. H. Massiah, M.A., M.D., C.M., M.L.C.
S. C. Thorne, Esq., M.C.P.
G. C. Mahon, Esq., M.C.P.
G. D. L. Pile, Esq., B.A., M.C.P.
J. D. Chandler, Esq., M.C.P.
The Director of Agriculture is an *ex officio* member of the Board.

Lt.-Col. The Honourable Sir F. J. Clarke, who was appointed as Government member, resigned his seat on the Board in August and Hon. Dr. W. B. H. Massiah was appointed in his place.

The Honourable G. L. Pile was elected Chairman on December 31, 1929.

Dr. Massiah's appointment as Government member created a vacancy among the representatives of the House of Assembly on the Board, and Mr. E. S. Robinson, M.C.P., was appointed to fill this vacancy.

The following acted on the Board during the absence from the Colony of various members of the Board:—D. A. Clarke, Esq., Captain A. R. Fellowes, and Charles Packer, Esq., Jnr.

The Board held fifteen meetings during the year.

SECTION III.—EXPENDITURE AND REVENUE.

EXPENDITURE.

Personal Emoluments	£7,757	14	3
Travelling Allowances	944	14	8
Overtime Allowance	36	10	0
Appointment Expenses of Scientific Officers	47	8	5
Expenses in Control of Sugar Cane Mosaic Disease	1,699	12	11
Expenses in Control of Pink Bollworm of Cotton (Salaries of Sub-Inspectors of Plant Diseases)	256	17	3
Experiment Stations	3,151	2	7
Government Laboratory and Sugar Cane Analytical Laboratory	1,203	13	1
Sugar Polarization Laboratory	868	4	6
Sampling of Foodstuffs and Fertilizers	20	1	0
	£15,985	18	8

REVENUE.

Sale of Ornamental Plants	30	5	0
Sale of Produce from land leased to the Department	65	18	10
Fees for analysis of Sugar and Molasses	1,735	10	0
Fees for analysis of Miscellaneous Samples	163	9	0
	£1,995	2	10

SECTION IV. PLANT INTRODUCTION, DISTRIBUTION AND IDENTIFICATION.

The importation of seeds of various ornamental flowering trees and shrubs was continued during the year.

Importation of seeds and tubers of economic plants is mentioned elsewhere. The distribution of plants during the year was as follows:—

(a) Ornamental flowering trees	356
(b) Ornamental foliage trees	53
(c) Other ornamental plants	619
(d) Fruit trees	114
(e) Arbor Day free distribution	5,870

The Department undertook the organization of the distribution to plantations of sugar cane cuttings of new varieties recommended for trial.

During the course of the year the Department identified a number of plants for enquirers.

SECTION V.—NOTES ON THE SUGAR CANE INDUSTRY.

The figures in the last column of the subjoined Table of Exports of Sugar and Molasses show the exports for the year 1929.

The season of growth of the 1928-30 sugar cane crop was somewhat more favourable than that for the preceding crop. There was an abundance of rain during the germination period of November and December which permitted of a good take throughout the Island. The period from January to May, 1929, was somewhat more favourable than for the corresponding period of 1928 with the exception of the month of March which was exceedingly dry. The precipitation during the period July to August was normal and the crop responded to the rains. There was a severe dry spell in certain districts during the second and third weeks of September which was responsible for a check in growth of the crop in these areas. Although the months of October and November were by no means as wet as in 1928, yet there was a sufficiency of moisture in the soil to sustain rapid growth of the crop. Comparatively normal conditions prevailed from December, 1929, to the end of the reaping season in 1930; nevertheless, as in previous years, there was a gradual diminution in the tonnage of cane per acre as the reaping season progressed. There was, however, a decided decrease in the percentage of what may be termed true "rotten" canes. The juice was of a good standard throughout the season with a high sucrose content.

The variety B.H.10 (12) continued to occupy a high percentage of the crop in the wetter districts and the Ba. 11569 held a similar position in the drier districts.

According to the Customs Returns for the year 1929, 62,107^{17} tons of vacuum pan crystals, 3,408^{17} tons of muscovado sugar and 8,035,779 wine gallons of molasses, equal at 110 gallons per puncheon to 73,052 puncheons of molasses of all grades, were exported of the total value of £956,206 made up as follows:—

Sugar	Tons	£	Value
Dark Crystals ..	62,107^{17}	683,187	
Muscovado	3,408^{17}	39,202	£722,389
	65,516^{14}		
Molasses	**Gallons**	**£**	
Fancy	6,377,435	212,581	
Choice	579,546	14,489	
Vacuum Pan ..	1,078,798	6,747	£233,817
	8,035,779		£956,206

TABLE SHOWING EXPORTS OF SUGAR AND MOLASSES FOR THE FIVE YEARS 1924–28 COMPARED WITH EXPORTS OF SUGAR AND MOLASSES FOR THE YEAR 1929.

SUGAR.	1924	1925	1926	1927	1928	Average 1924–28	1929
Dark Crystal	35,640	43,561	42,990	50,221	58,679	46,218	62,108
Yellow Crystal	31	10	..	..	..	8	..
White Crystal	1	..	..	..	..	..	..
Muscovado	5,668	3,889	2,795	2,885	3,980	3,843	3,409
Actual Sugar Crop, tons	41,340	47,460	45,785	53,106	62,659	50,069	65,517
MOLASSES.							
Fancy	4,998,298	6,880,789	7,085,523	7,294,202	6,199,477	6,491,658	6,377,435
Choice	818,365	761,822	431,608	501,640	481,555	598,998	579,546
Vacuum Pan	170,790	208,355	243,203	462,848	548,149	326,669	1,078,798
Barbados	..	7,188	..	..	..	1,438	..
Special	..	11,121	..	..	..	2,224	..
Total Molasses Crop, gallons ..	5,987,453	7,869,275	7,760,334	8,258,690	7,229,181	7,420,987	8,035,779

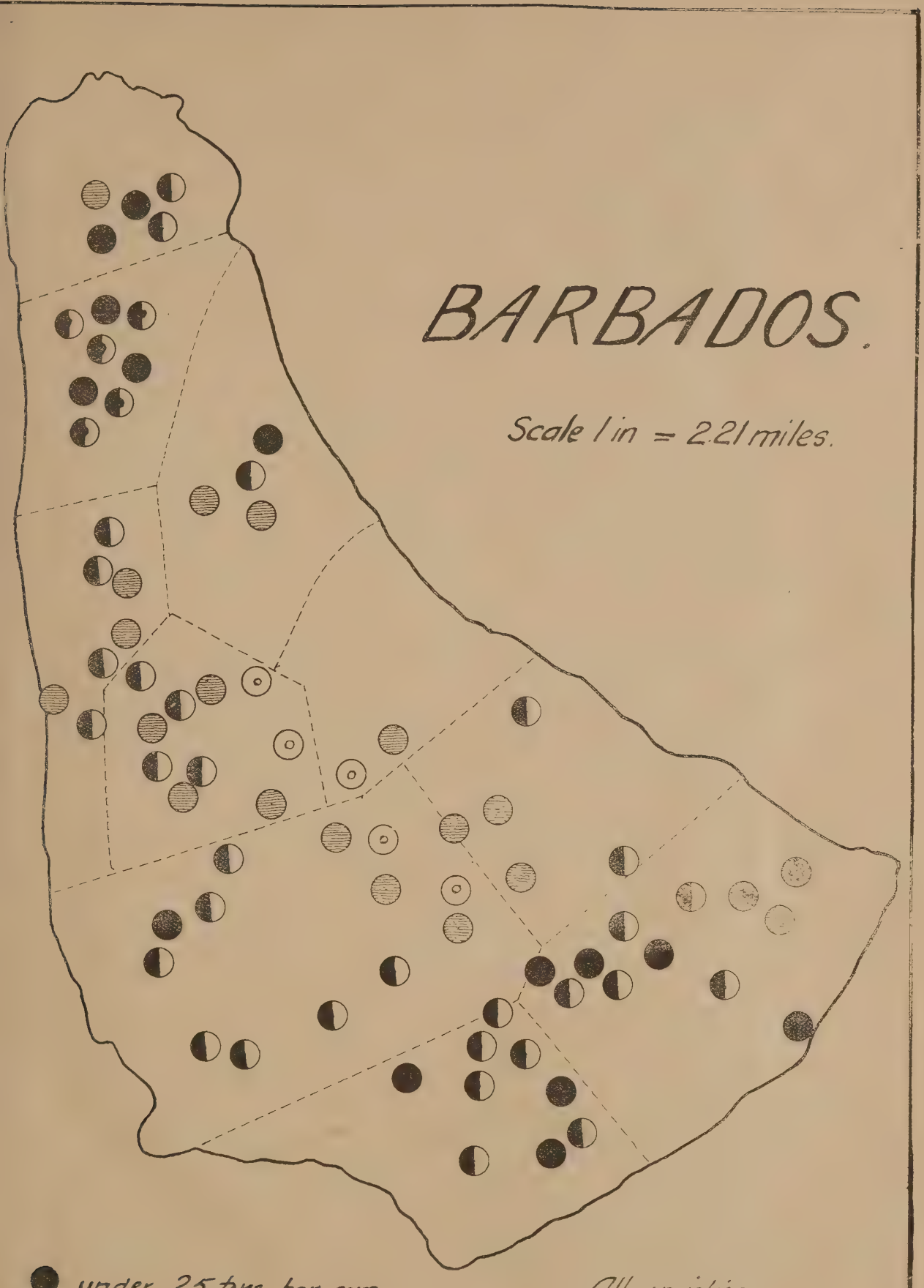
BARBADOS.
Scale 1 in = 2.21 miles.
under 25 tons per acre
between 25 - 30 tons per acre
between 30 - 35 tons "
over 35 tons per acre
All varieties

PLATE I

The continued depression in the sugar industry has been a source of grave concern to the British West Indies in general and especially to the Island of Barbados which depends almost entirely on this crop for the introduction of new money to the Colony.

The visit of the Sugar Commission, sent out by Lord Passfield, which in its report emphasised the urgent necessity for practical assistance to the industry, has resulted in no offers of help which can affect the immediate needs of planters.

Fortunately the larger proprietors have been able to make arrangements to carry on with the crop planted in November and December of 1929, but a continuance of present world prices can only result in either a considerable curtailment of the area under sugar or a drastic reorganisation of the industry. That the community as a whole are ready and eager to adopt any plan which may result in the eventual cheapening of the production of their staple commodity is evidenced by the numerous schemes commented on later in this report, in which schemes it is gratifying to record that the Department are either the moving force or else very close collaborators.

Apart from general improvements in agricultural practice and the more economic use of labour, the motto of the planting community is becoming "Co-operation." The manner in which all farmers have assisted in the liberation of the parasites of the moth borer of sugar cane and the greatly increased numbers who are collecting the beetles of the root borer and brown hardback has resulted, and will further result, in greatly diminished losses due to this pest, and in spite of certain adverse criticisms from outside sources as to the selection of the parasite for the moth borer it can now be said that an economic control of this pest is being achieved.

PEASANT AGRICULTURE.

While, as has been already stated, the larger holdings are in a position to carry on their cultivation of the crop already planted the position of the peasant farmer is exceedingly hazardous.

During the period under review an exhaustive investigation was conducted by the Assistant Director (Mr. C. C. Skeete, B.A.) whose admirable report has been published as a special bulletin.

The recommendations made by Mr. Skeete, with which I am in complete agreement, stress the following points:—

(i) The majority of peasant cultivators for one reason or another are not farming their holdings economically.

(ii) Practically all small proprietors have bought their land at an uneconomic price and have either none at all or insufficient working capital.

(iii) Every large estate which is broken up for sale to peasants rapidly loses fertility and so results in a loss of the Island's only source of "capital."

(iv) Holdings under five acres are uneconomic, and it is doubtful if sugar cane should be grown under these conditions.

PEASANTS' CREDIT SOCIETIES.

As a result of this report, it became obvious that the peasant should be assisted by the formation of Credit Societies to enable him to carry on his cultivation. The present Act passed in 1924 is of no use for practical application and after the possibilities of forming such societies had been investigated by the appointment of a temporary officer, the Department were very greatly assisted by a visit of Mr. C. Y. Shephard, Professor of Economics in the Imperial College of Tropical Agriculture, whose preliminary report, which has been of extreme value, advocates unhesitatingly the immediate formation of these societies.

Steps have been taken therefore to amend the present Act and as soon as the necessary legislation has been enacted Societies will be organised. It is realised that such Societies, if founded on insecure bases, can only result in a serious setback to this type of assistance to peasant agriculture and therefore it is hoped that only a limited number will be formed at first until such time as experience has shown us the surest means of running them successfully.

CO-OPERATIVE MARKETING OF GROUND PRODUCE AND VEGETABLES.

The Department has been largely instrumental in the preliminary discussions for the formation of a Society for the Co-operative Marketing of vegetables and ground produce. In 1929 almost 2,000,000 lb. of sweet potatoes were exported to British Guiana from the Colony, and it is felt that, by a strict system of grading all export produce of this nature, the profits may be more equitably distributed and prove of real assistance in lowering the cost of production of sugar.

In this report, it is gratifying to record the spirit of co-operation between planter and peasant which these discussions have revealed.

RE-ORGANISATION OF THE BARBADOS AGRICULTURAL SOCIETY.

It had been felt in various quarters for some time past that the Agricultural Society, while conducting a very admirable Agricultural Exhibition each year, could be of very much greater assistance to agriculture and the community as a whole if the scope of its work could be extended, and a scheme has been worked out in which the Department has collaborated and which should result in every interest, merchant, factory and planter, contributing to make the Society what it should be, namely, the right hand of this Department.

AGRICULTURAL CENSUS.

1930 was selected by the International Institute of Agriculture at Rome for the taking of a World Agricultural Census, and during the first quarter of the year an endeavour was made to conduct this work.

While the larger landholders co-operated loyally in submitting returns it is regretted that this was far from being the case with the smaller proprietors, who viewed the whole affair with the suspicion that this was a Government scheme to introduce increased taxation. Nevertheless returns for seventy-five per cent of the acreage of the colony were received. It should be emphasised, however, that any scheme for work of this nature requires legislative support.

THE YIELD OF SUGAR CANE PER ACRE IN BARBADOS.

The necessity for an accurate knowledge of the tonnage of sugar cane per acre grown throughout the island is obvious, and during the past crop season a preliminary investigation was conducted with this end in view. One hundred and seven plantations were asked to submit weekly returns throughout the crop season of the tonnage of the different varieties of sugar cane cut during the previous seven days. Seventy-seven submitted returns and from these returns it has been possible to ascertain the average yield of all varieties over three periods:—

(a) Early crop—up to March 1
(b) Middle crop—from March 2—April 5
(c) Late crop—after April 5.
(d) Whole crop—over whole period.

These worked out at 29.4, 28.8, 25.9 and 28.5 tons per acre respectively for the Island.

The following table gives the returns by parishes.

Average Tonnage of Canes of all Varieties Per Acre.

Parish.	Period.			
	(1) Up to March 1	(2) March 2—April 5.	(3) After Apirl 5.	Whole crop.
St. Lucy	28.0	25.9	21.7	27.1
St. James	29.6	32.3	26.0	29.6
St. Andrew and St. Joseph	32.0	29.4	31.7	30.0
St. Philip	27.0	25.6	21.0	25.9
St. George	32.3	33.7	29.0	31.5
St. Michael	27.1	25.7	25.2	26.0
St. John	33.7	32.0	29.0	32.3
Christ Church ..	25.4	26.2	26.0	25.6
St. Thomas	32.2	32.1	29.8	31.1
St. Peter	27.1	25.0	19.2	26.0
Average	29.4	28.8	25.9	28.5

BARBADOS.
Scale 1 in = 2.21 miles.
under 25 tons per acre.
between 25 - 30 tons per acre
between 30 - 35 tons per acre
over 35 tons per acre
Whole crop 10 (12) P.C.

PLATE II

Plate I shows the average yield of the whole crop of all varieties throughout the Island, while Plates II and III show the average yield of the varieties B.H.10(12) and Ba.11569 respectively.

From similar returns collected in future years it is anticipated that information on the following points will be obtained:—

(a) the answer to the contentious problem as to whether any particular variety of sugar cane deteriorates with the progress of the years;
(b) in what way a plantation recording a larger yield than its immediate neighbours achieves this success;
(c) what are the reasons for a plantation recording a smaller yield than its immediate neighbours;
(d) whether particular varieties are more suited than others to the Island as a whole, and to districts in particular.

Plate I might be regarded as a "rainfall" map of Barbados as in general it follows very closely the annual precipitation measured in the various plantations and this stresses further the urgent necessity of conserving all soil moisture by the growing of green manures and by trashing.

SECTION VI.—EXPERIMENTAL WORK OF THE DEPARTMENT.

A. ECONOMIC BOTANY.

The work of the Geneticist is reported more fully in Chapter II.

COTTON.

The effective nature of the close season for cotton carried out in 1929 is evidenced by the fact that no Pink Bollworm has been reported as present in the Island during the period under review.

A pamphlet has been issued (No. 4 of 1930) advocating the extensive planting of windbreaks and a much closer planting, which, it is anticipated, given a favourable season, will result in a greatly increased yield from the 2,000 acres which planters propose to place under cotton this year.

The planting date has been brought forward to September 1st except in certain areas of St. Philip and St. Lucy, where planting will be allowed from August 16th.

The work on cotton breeding has been abandoned as reports on samples of cotton continue to show Barbados cotton to be superior to all other lints and it has been felt, therefore, that greater success will be achieved by the rigorous selection of the best types of seed rather than by the introduction of new strains of cotton from outside.

TOBACCO.

The absence of an open market for tobacco has resulted in a setback to this industry, but arrangements have been made for this season for the marketing locally of a limited area of the crop.

Under the present circumstances of the industry it is not proposed to pursue the Departmental variety and curing trials at the present juncture. The good burning properties of Barbados tobacco is however worthy of note.

SUGAR CANE.

Sugar cane variety trials have been continued on the randomised block system and an account of the results is given later in the report. The phenomenal success obtained by the two new canes B.726 and B.891, which are now almost at the commercial stage, gives every indication of a greatly increased export of sugar in the near future. The yield of the former's first ratoons at the rate of 15,000 lb. of sugar per acre with a rainfall of sixty inches is especially gratifying.

The correlation trials, being conducted by the Geneticist, will it is hoped determine how much actual and relative importance can be paid to the commercial features of tonnage and sugar in the juice of a seedling by the analysis of a single stool in the first year.

Spacing experiments in hand will settle whether the present cane-hole system of farming must be considerably modified to obtain increased tonnage at a lower cost per ton of cane.

SWEET POTATO.

Work on the trial of

(a) varieties, and
(b) seedlings

of the sweet potato is continuing and the results to date give every indication that the search for potatoes with good storage properties for the non-scarabee area and quick maturing, high-yielding types for the scarabee area is materialising.

ECONOMIC LEGUMES AND COVER CROPS.

The trials with economic legumes and cover crops are reported on by the Geneticist. The need for Barbados is a quick maturing bean or pea as a catch crop and further investigations are proceeding with four varieties of Groundnuts and over twenty varieties of Soya Beans, from which it is hoped to secure types more suitable to the local conditions than those already under trial.

The cover crop experiment followed by the B.726 sugar cane variety will not be reaped till 1931, but it can be stated now that the varieties of cover crop suitable for Barbados are limited greatly by the fact that our staple crop is a temporary crop and not of a permanent nature such as tea or coffee. Excellent cover crops such as *Tephrosia candida* and members of the species *Crotalaria* require such a lengthy period to become established that this precludes their use.

SUNFLOWER.

Four varieties of Sunflower were introduced from Rhodesia in February, 1930, and these were planted at Codrington for observation. Fuller details of the experiment are given in the Geneticist's report, but the objects of this and future trials with oil seeds may be stated here. Apart from cotton no oil producing crops are at present grown in the Island. During 1929, 1,359 tons of cotton seed were imported for the preparation of domestic cooking fat and cattle meal. It is hoped by planting quick growing crops of the sunflower type to replace to a certain extent this importation and to benefit the soil by turning in the trash, which in the case of the crop under review is exceedingly heavy.

It is hoped that, by planting immediately the earlier canes are harvested, it will be possible to get these crops harvested before it is necessary to prepare the ground for the short crop sweet potato or cotton both of which follow sugar. In this way an extra crop requiring little preparation or cultivation will be added to the rotation.

In Rhodesia the sunflower produces admirable results under six inches of rain.

MAIZE.

Four varieties of maize have been introduced with a view to earlier maturity and increased resistance to weevil attack but these have not yet been harvested.

SERICULTURE.

Three varieties of *Morus* have been secured in order to see whether the food of the silkworm will succeed in Barbados. If this is the case the Department propose to import silkworm eggs and carry out an extensive trial on the possible production of this valuable peasant industry.

BARBADOS.
Scale 1 in = 2.21 miles.
under 25 tons per acre.
between 25 - 30 tons per acre.
between 30 - 35 tons per acre.
over 35 tons per acre.
Whole crop 11569 P.C.

PLATE III

B. CHEMICAL SECTION.

An account of the work of this section is given by the Agricultural Chemist in his report, Chapter III.

Work on the control of sugar manufacture by means of the Zeiss Refractometer was continued at Carrington Factory during the 1930 crop season. That the practical value of this work is realised is evidenced by the fact that certain factories have now introduced this method into the commercial manufacture of their sugar, thereby lowering the cost of production and also putting their factory technique on a scientific basis rather than depending on the empirical methods formerly in use.

Plate indicates that the soil survey of the Island is progressing. The similarity of the soils of the Island is noteworthy and facilitates the problems which confront the plantbreeder and the chemist alike.

Unfortunately the soil survey can only be carried on out of the crop season, as the analytical assistants, employed in the analyses of trade sugars, only are available for the work.

The manuring of sour grass trials of which more detailed information is made available in the Chemist's report has a vital bearing on agricultural practice in the Island. The greatly increased yield of grass should enable cane fields to be trashed in early January, that is, the time when trashing is of real benefit for the preservation of soil moisture and such applications can only result in prolonging the life of the cane crop especially in the drier districts thereby causing less rotting and so increased yields of sugar.

The manurial trials on the sugar crop itself are proving to the planter that too much money has been spent in the past on mixed trade manures and a saving of approximately twenty dollars an acre or sixty-six cents per ton of cane can generally be made.

The difficulties experienced by syrup manufacturers in inverting the juice have received the attention of the Chemical Staff and work on a "quick vinegar" process is progressing favourably.

The usual routine analyses for Government and the public have been carried out and recent cases before the Courts would indicate that a thorough revision of the Food and Drugs Act is overdue.

The Department continued the analyses of trade sugars and it is hoped that this lucrative section of the Department's activities may be put on a permanent basis at an early date.

While the Department is at all times ready to help both planter and public to the best of its ability yet the constant drain upon the time of the Agricultural Chemist in giving advice to factories and syrup manufacturers is increasing to such an extent that either very necessary research work must be curtailed or the appointment of an Assistant Sugar Technologist considered.

C. ENTOMOLOGICAL SECTION.

The report of the Entomologist is presented in Chapter IV.

The value of the control of the sugar cane moth borer (*Diatraea saccharalis*, Fabr.) by the egg-parasite (*Trichogramma minutum*) has been recognised by all interested in the sugar industry and the high purity of the juice maintained throughout the season has been in no small measure due to this control. As the Entomologist points out in his report the average weight of canes has increased in addition to the greatly reduced numbers of attacked and rotten canes and with the provision of an additional unit for the breeding of the host moth (*Sitotroga cerealella*) the number of parasites available for liberation has increased considerably.

The provision of this fourth unit means that for the future liberations will be made throughout the year with no "close season".

Estates which picked beetles regularly last year report greatly decreased attacks of the sugar cane root borer (*Diaprepes abbreviatus*, Linn.) and the brown hardback (*Phytalus smithi*) and the continued increasing co-operation of the great majority of planters leads us to the hope that these pests may shortly be subjected to a certain measure of control.

D. VETERINARY SECTION.

Owing to the protracted ill health of the Veterinary Officer (which eventually necessitated his return to England on sick leave) the work of the above section has been greatly disorganised and no separate report has been submitted.

In addition, the fact that since January 1st, 1930 the Veterinary Officer has been responsible for the inspection of all meat killed in the public market at Bridgetown, limits the usefulness of the Veterinary Officer to about two hours per diem.

Under these circumstances it has not been found possible to proceed to any extent with the very essential work necessary for the improvement of the local milk supply, the betterment of the rations supplied to dairy and estate oxen and the thorough investigation of the outbreak of contagious abortion.

In connection with the latter disease, in response to a questionnaire circulated by the Department fifteen estates and cowkeepers reported the premature dropping of calves within the past two years and arrangements have been made to investigate immediately any further cases which may be notified.

SECTION VII. PEASANTS' AGRICULTURAL EXHIBITION.

The usual Exhibition for Peasants and Elementary School children was held, with the kind permission of the Management of the Belle plantation, on December 4, 1929, at Belle plantation, St. Michael.

The Exhibition was very successful and was well attended.

Exhibits were, on the whole, satisfactory. In several instances, there were specimens of vegetables and fruit which were as good as or better than, many of those exhibited at the bigger Show, the Annual Industrial Exhibition.

At these Exhibitions too great a proportion of the prizes is secured by schoolmasters, who usually have better facilities for growing fruit and vegetables than the peasants themselves. The result is that numbers of small farmers, who otherwise would compete, are discouraged from entering. For the future, however, these fruit and vegetable classes will only be open to genuine peasants and tenants of sugar estates.

The institution of a ring for the animal classes and a parade of the winners proved most popular and the animal classes were a great improvement on previous years.

The interest evinced every year by the school children was fully maintained. The number of exhibits of plants growing in half barrels, boxes and tins and in the vegetable section was up to standard. The agricultural work attracted a large number of competitors.

The award of prizes to the Head-teachers for the Best Kept School Garden was made as follows:—Messrs T. O. Phillips, Southborough Boys, O. Walcott, St. Joseph Boys, E. G. Smithwick, Hilloby Combined, and E. W. Alleyne, Mt. Tabor Boys.

His Excellency the Governor visited the Exhibition and distributed the prizes.

Mr. T. O. Phillips won first prize for agricultural work performed by boys and Miss I. Bradshaw, St. Patrick's, first prize for work performed by girls.

SECTION VIII. CROP DISEASES AND PESTS.

The situation with regard to pests and diseases of crops is reported elsewhere.

On October 18, Professor Briton-Jones, Mycologist of the Imperial College of Tropical Agriculture, confirmed the presence of the gumming disease of the sugar cane in Barbados.

As the planting season was almost about to begin it was necessary to make planting recommendations in the light of the knowledge available from other Islands of the West Indies.

Fortunately no actual gumming of the canes was reported and it would appear that up to the present the incidence of the disease is of a mild nature and moreover one which does not apparently affect the yield of sugar per acre.

Comprehensive experiments have been put in hand to determine:—
(a) the extent to which individual varieties are liable to attack, and
(b) the rate of spread of the disease, and
(c) the extent of damage caused by the disease.

The results of these experiments, however, will not be available till after the crop has been reaped in 1931.

SECTION IX. METEOROLOGICAL OBSERVATIONS.

A summary and the details of the meteorological observations recorded at the Meteorological Station, Codrington, appear in Appendix I and Appendix II.

SECTION X. VISITORS AND VISITS.

Among the visitors to the Department during the year under report were His Excellency the Governor Sir William Robertson, K.C.M.G.; Dr. J. G. Myers, Entomologist to the Empire Marketing Board; Mr. C. Y. Shephard, Professor of Economics, Imperial College of Tropical Agriculture; Dr. H. R. Briton-Jones, Mycologist and Bacteriologist, Imperial College of Tropical Agriculture, and a party of students; Mr. E. A. McCallan, Director of Agriculture, Bermuda; Mr. F. G. Harcourt, Curator and Agricultural Superintendent, Dominica; Mr. A. E. Collins, Superintendent of Agriculture, Antigua; and Mr. E. A. Walters, Agricultural Superintendent, St. Lucia.

The Director and the Geneticist attended the Agricultural Conference of the West Indies held at the Imperial College of Tropical Agriculture, between January 23rd and 29th.

SECTION XI. PUBLICATIONS AND LECTURES.

Publications issued by the Department during the year, in addition to the Annual Report for the previous year, were:—

(1) Pamphlet No. 3—"Notes on Insect Pests of the Sugar Cane" by R. W. E. Tucker, M.A., B.Ed.
(2) Pamphlet No. 4.—"Cotton" by the Department.
(3) "The Condition of Peasant Agriculture in Barbados" by C. C. Skeete, B.A.

A paper on "The Results of, and Recommendations from, Sugar Cane Variety Trials and Maturity Experiments during Crop Season 1928—30" was read by the Geneticist to the Agricultural Society.

Since January, 1930, the Department has published weekly articles in the Press. The titles of these are as follows:—

January 18.—Preliminary Report on the Coral Limestone Soils of Barbados by S. J. Saint, B.Sc., A.I.C.
„ 25.—Sugar Cane Root Borer, by R. W. E. Tucker, M.A., B.Ed.
February 1.—The Organic Matter of the Soil, by S. J. Saint, B.Sc., A.I.C.
„ 8.—The Improvement of the Sweet Potato, by A. E. S. McIntosh, B.Sc., Ph.D.
„ 15.—Insects and Agriculture, by R. W. E. Tucker, M.A., B.Ed.
„ 22.—Milk and Milk Supply, by Lt. Col. H. Greenfield, M.R.C.V.S.
March 1.—Insects vs. Insects, by R. W. E. Tucker, M.A., B.Ed.
„ 8.—A Close Season for Cotton and Okras.
„ 15.—Some Strange Insects, by R. W. E. Tucker, M.A., B.Ed.
„ 22.—Hydrogen ion Concentration and the Control of Sugar and Syrup Manufacture, by S. J. Saint, B.Sc., A.I.C.
„ 29.—Cotton Prospects in Barbados, by A. E. S. McIntosh, B.Sc., Ph.D.

April 12.—The Quality of Foodstuffs in Barbados,
by C. A. Coppin, B.A.Sc.,
„ 19.—Peasants Agricultural Credit Societies.
„ 26.—Insect Pests of Cotton,
by R. W. E. Tucker, M.A., B.Ed.
May 5.—Nutritive Value of Sour Grass,
by S. J. Saint, B.Sc., A.I.C.
„ 17.—Sugar Cane Breeding in Barbados,
by A. E. S. McIntosh, B.Sc., Ph.D.
„ 23.—The Measure of Moth Borer Control,
by R. W. E. Tucker, M.A., B.Ed.
„ 31.—Sugar Cane Breeding in Barbados—The Particular Problem for Barbados,
by A. E. S. McIntosh, B.Sc., Ph.D.
June 14.—Manuring of Sugar Cane in Barbados,
by S. J. Saint, B.Sc., A.I.C.
„ 21.—Root Borer Control,
by R. W. E. Tucker, M.A., B.Ed.
„ 28.—Suggestions for the Control of the Scarabee,
by R. W. E. Tucker, M.A., B.Ed.

SECTION XII. ACKNOWLEDGMENTS.

The Director of Agriculture desires to record his appreciation of the assistance rendered by

(1) The Board of Agriculture throughout the year.
(2) The Management of Lion Castle plantation by granting the Department the use of the land for conducting sugar cane breeding work and by facilitating the work in every way possible.
(3) The Management of Carrington Factory by permitting the Agricultural Chemist to conduct research work in Sugar Technology in Carrington Factory during the grinding season of 1930.
(4) The Management of the Belle plantation by permitting the use of the factory and yard at the Belle for holding the Peasants' Agricultural Exhibition.
(5) The Managements of Coverley, Lears, Bennetts, Warleigh and Black Bess by selling canes to the Department for the purpose of distributing healthy cane cuttings to areas infected with mosaic disease.
(6) The Management of Applewhaites plantation by granting the use of land for sweet potato experiments.
(7) The Managements of Blackmans and Malvern plantations by granting the use of land for cotton experiments.
(8) The Managements of Vaucluse and Graeme Hall plantations by granting special facilities for maintaining maturity experiments until the end of the reaping season.
(9) The United States Department of Agriculture by supplying this Department with cuttings of sugar cane varieties passed through quarantine and by supplying seeds of various economic plants.
(10). Dr. W. R. Thompson, Superintendent, Farnham Royal Parasite Laboratory, by supplying *Microbracon kirkpatricki* for control of *Pectinophora gossypiella.* (These parasites were transferred to Trinidad).
(11) Dr. J. G. Myers, Entomologist to the Empire Marketing Board, by supplying 198 pupae of *Lixophaga saccharalis* from Cuba for biological control of *Diatraea saccharalis.*
(12) Mr. C. Y. Shephard, Professor of Economics, Imperial College of Tropical Agriculture, for his great assistance in assessing the possibilities of forming Peasants' Credit Societies in the Island.

Chapter II.

ECONOMIC BOTANY.

REPORT OF THE GENETICIST.

(A. E. S. McINTOSH, B.Sc., Ph.D.)

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SECTION I. SUGAR CANE.

(*a*) INTRODUCTION.

As has been stated in the Report of the Department for 1928–29, the objective is to continually increase the yield of sugar per acre from canes grown.

This section deals with operations in the field and more particularly with the aspect of improvement through the production of varieties better adapted than those existing at present to give a high production of sugar per acre at any place at any time during the crop season.

In the Report of the Department for 1928-29 the necessity for evolving, by breeding, seedlings for particular places and times in the crop season was pointed out. This has been made more evident by the results of certain experiments (q.v. page 35 et seq.). As will be seen from these experiments, the crop season extends over a period which is longer than the time that the varieties at present grown commercially can maintain individually or collectively their highest possible sugar per acre return. There is a period early in crop when juice qualities are low and towards end of crop tonnages drop off considerably. These are unprofitabe times with the present varieties grown in the Island, and there is an urgent necessity to obtain (1) earlier maturing varieties (so far as sugar in the juice is concerned) and (2) varieties which retain their tonnage during the difficult dry period usually experienced towards end of crop.

It will be seen that Java and Indian canes have been introduced and crossed with our own varieties with a view to widening the range of genotypic expression in our seedlings in the hope of obtaining types which will suit for the abovementioned unprofitable periods, i.e., with a view to ensuring the factory always milling canes from fields containing the optimum amount of sugar per acre.

(*b*) SUGAR CANE BREEDING.

This was carried out as in 1928 at Lion Castle plantation during the arrowing season, October—December, 1929.

On page 37 of the 1928—29 Report can be seen the method of attacking the problem of prolonging the optimum sugar per acre return for two districts of broad climatic distinctions in the Island. It was there seen that seedlings were being produced for different categories, and in the light of this year's experiments—to be detailed later in this report—it will be seen that this procedure is justifiable. It has therefore been retained.

It is obvious, however, that until more is known concerning the hereditary tendencies in definite parental groupings, these latter cannot be tried in one group only—i.e., early, medium or late at high and low rainfall stations. Accordingly the following system is now adopted in breeding.

Female plants of known commercial value or which are known to be valuable mother plants (e.g. P.O.J. 2364) are chosen and each is crossed with a wide range of selected Barbados commercial male plants. Thus, numerous parental groupings are made. Now any "batch" (when numbers of seedlings resulting from the cross permit) is planted out in sufficient numbers in each group (early, medium and late) at one station only (for the labour supply necessitates this restriction to a drier station only in the first year) to determine firstly, in which group it performs relative to other "batches" (seedlings derived from a definite parental grouping) at its best and secondly for any group, how it actually stands in the merit list (the latter is mainly judged on features of weight, percentage of sucrose in the juice, cane and habit features). Thus for any group the best crosses will be determined. These will be persisted with, the poorer ones dropped out and further groupings tried in future years. There will thus be a continuous cycle of work; trying out crosses in all groups in numbers only large enough for a reliable estimate of their worth, retention and expansion of representation of the proved ones and elimination of the inferior ones.

The following plants were used for breeding material:—

(a) females—P.O.J.2364, P.O.J.2725, P.O.J.2379, Co.213 and Ba.11569;

(b) males —B.831, B.391, B.417, B.H.10(12), B.374, B.755, B.606, Ba.6032, and B.605.

As a "safety valve," in the event of there not being an adequate number of seedlings from crosses, seeds were collected from unprotected arrows of B.891,

B.755, B.417, B.606, B.374, Ba.6032, B.605. It is realised that such open arrow collections may give seedlings which are quite as good as those from controlled crosses but the male plants are not known in these cases and the already present chance element in sugar cane breeding could certainly not be decreased by the perseverance with seedlings from unknown and promiscuous crosses.

The female varieties were conveniently planted around the breeding station house, while the male variety plots were scattered in randomised block fashion behind them. Protection of the flowering arrows of the female plants was effected by arrow lanterns (q.v. Report of Barbados Department of Agriculture 1927—28). In any female plant four arrowing canes were allowed to grow up into the lantern and their arrows to emerge from their sheaths, expand and flower under protection from pollen drifting about the breeding field. The remaining canes in the stool were cut. Precautions were taken to prevent the arrows as far as possible from touching the glass sides by suitably fixing the arrow bearing canes in positions to direct their growth to the centre of the lantern.

As a result of extensive observations of varietal daily periodicity in pollen shedding, collections of chosen male arrows were made at 6.00 a.m. to 6.30 a.m. This is the period just prior to optimum anther protrusion and dehiscence (q.v. later). The arrows of each variety were gathered into brown paper sheets (one for each variety), carried into the breeding house and allowed to lie until 7.00 a.m. Protrusion and dehiscence continued at this time, but as there was no movement the grains were retained in the anthers. As a result when dusting operations were carried out from 7.00 a.m.—7.30 a.m. clouds of pollen were shed from each arrow. In each lantern inspection was made to see that there was a considerable deposition of grains on the receptive stigmata of open female flowers.

All crossing work for any day was completed by 7.45 a.m. or at latest 8.00 a.m.

Any one lantern had its arrows dusted from the inception of flower opening until the last flower opening in the latest arrow. The work was considerably facilitated by the knowledge derived from two years work on varietal periodicity in arrow protrusion, flowering duration and flower opening.

On completion of dusting operations in any lantern, its canes were allowed to mature their arrows until the fuzz in all or any one arrow was shed appreciably on gently tapping the supporting canes. These arrows were considered to have ripened their seeds and were collected in cotton bags, taken to the sowing station at Codrington and allowed to dry for a varying number of days before sowing.

Sunshine records, air temperature, air humidity and rainfall records were taken throughout the breeding season by means of a sunshine recorder, thermograph, hygrograph and rain guage respectively and personal daily observations were made on air movements.

An attempt was made to correlate these climatic phenomena with the flowering phenomena—flower opening, anther protrusion and anther dehiscence. It was felt that there was need for evaporation records especially in connection with anther dehiscence, for even the subjective observations on air movements coupled with air temperature and especially humidity hinted that this phenomenon could be expressed as a part resultant of the evaporation intensities prevailing. Steps have been taken to introduce or make a model of the Sayre's continuous recording Atmometer (see Ecology IX, No. 2., p. 123, 1928).

As is usual during the breeding season notes were made on the following arrowing and flowering phenomena:—

(1) The times and extent of arrowing and the times taken for arrow emergence and complete flowering in varieties, B.663, B.605, B.417, B.755, Ba.11569, B.831, B.891, B.391 and P.O.J.'s 2364, 2725 and 2379.

(2) The extent of development reached by the sexual structures in all parent varieties. Particular work was done during this season on daily periodicity in flower opening, anther protrusion and dehiscence. The effect of variety and climatic conditions on the extent and time of pollen shedding was closely observed.

The actual experiments will be detailed in a separate paper, but a summary of the results of observations is presented below :—

(I) *Flower Opening.*

(1) Growth of the arrow is greater during the day than during the night.
(2) Flower opening takes place during the night only and precedes anther dehiscence by about three hours.
(3) Flower opening continues throughout the night, but is greatest around 4.00 a.m.
(4) Open flowers commence closing about 7.30 a.m. and have practically all closed by about 10.00 a.m.
(5) The cause of flower opening is ascribed to some inherent fixed daily rhythm in the plant coupled with conditions of the environment affecting through the plant the turgor pressure in the lodicules.

(II) *Anther Dehiscence and Pollen Shedding.*

(1) The period of maximum amount of pollen shedding is between 7.30 a.m. and 8.00 a.m. when all varieties are considered collectively.
(2) This optimum period is departed from by B.606 and B.H.10(12) whose shedding is greatest at 7.00 a.m.—7.30 a.m. and 6.00 a.m. —6.30 a.m., respectively.
(3) Varieties differ in the duration of their shedding times. B.391, B.374, B.663, B.H.10(12) shed appreciably over long periods, while B.606 sheds in considerable amount over a comparatively short lapse of time. Ba.11569, White Transparent, B.831, B.891 and B.755 shed feebly in a short time.
(4) The amount and time of pollen shedding varies within the variety within the period of the arrowing season. As time progresses in the variety's arrowing period the amount of pollen shed falls off and moreover, the peak of shedding is earlier (data from var. B.606).

The former may be a growth phenomenon, peculiar to varieties, while the latter is considered due to a heightened evaporation rate increasingly earlier in the morning as the arrowing season progresses.

(5) It is considered possible that dehiscence itself is brought about by a high internal pressure in the anther cells coupled with a rise in evaporation rate around the time of commencement of greatest shedding. Shedding prior to 6.00 a.m. may be due to dehiscence resulting from high internal pressure only and dehiscence after that hour is accentuated by an increasing evaporation rate.

The points summarised under (1), (2), and (3) above are of immediate practical significance. From (1) and (2) is known the most profitable time to carry out dusting operations and from (3) it is seen that some male varieties can be used as females for the period between the commencement of their shedding and that of the varieties shedding appreciably over hours before such time. Thus B.606 may be crossed with B. 663, B.391, B.374, etc., before it itself starts to shed pollen. This makes possible the extension in numbers of possible genotypes in seedlings even within the Barbados canes. It is hoped to use B.606 as a female plant next breeding season.

The mature arrows were collected at Lion Castle and carried to Codrington Experimental Station where all sowings and subsequent plantings out are made.

After being allowed to mature for a varying number of days (q.v. later), the fuzz is stripped from the arrows and sown in boxes. The resultant germinations are noted. At sowing it is the endeavour to apportion, so far as possible, an equal amount of fuzz to each box, so the box is taken as the unit to determine the relative fertility of the various crosses. These are listed here in Table I.

TABLE I.

SUMMARY OF GERMINATION DATA—CODRINGTON 1929–1930.

I.—CONTROLLED CROSSES.

Parentage.			No. Boxes sown.	No. Seedlings obtained.	Mean No. seedlings per box.
P.O.J.2364	x	B.831	8	12	1.5
„	x	B.391	9	299	33.2
„	x	B.605	10	32	3.2
„	x	B.H.10(12)	22	325	14.8
„	x	B.374	17	331	19.4
„	x	B.606	25	71	2.8
„	x	B.417	6	59	9.8
P.O.J.2725	x	B.H.10(12)	32	502	15.7
„	x	B.606	28	37	1.3
„	x	B.374	31	197	6.4
„	x	B.831	15	93	6.2
„	x	B.391	19	721	38.0
P.O.J.2379	x	Ba.6032	18	16	0.9
„	x	B.374	23	81	3.5
„	x	B.H.10(12)	19	14	0.7
Co.213	x	B.H.10(12)	10	19	1.9
„	x	B.374	8	28	3.5
„	x	B.606	9	8	0.9
B.891	x	B.374	8	340	42.5
„	x	B.606	72	18	0.3‡
„	x	B.391	25	9547	382.0
„	x	B.H.10(12)	63	13	0.2‡
Ba.11569	x	B.606	65	2355	36.2
„	x	Ba.6032	18	5447	302.6
„	x	B.417	19	3364	177.0
„	x	B.605	19	970	51.0
„	x	B.391	36	6110	170.0‡
„	x	B.H.10(12)	82	15714	191.6
„	x	B.831	17	612	36.0
„	x	B.374	29	1151	40.0‡
„	x	B.755	6	991	165.2

II.—FUZZ FROM OPEN ARROWS.

Ba.11569	55	14521	264.0
Ba.6032	12	221	18.4
B.755	7	2523	360.4
B.391	11	4313	392.1
B.374	14	1982	141.6
B.606	18	2667	148.2
B.417	16	530	33.1
B.605	21	3887	185.1
B.891	10	4167	416.7
B.831	19	7211	380.0
P.O.J.2725	17	1755	103.2
P.O.J.2379	24	91	3.8
P.O.J.228	13	0	0.0
P.O.J.2222	8	0	0.0

‡These denote sowings made from arrows with sheath rot.

It is seen from the table that P.O.J.2379 and Co.213 gave poor germinations. The number of crosses and sowings effected will have to be considerably increased to obtain an adequate number of seedlings to test their progenies on a sufficiently large scale.

Fuzz from open arrows give consistently high germinations and it may be that protection of the arrows of controlled crosses by lanterns may depress ovule fertilisation and more especially seed maturation. From the data on germinations of the seed from controlled crosses, however, it is seen that with many crosses, high germinations are obtainable and argues for the considerable efficiency of the method.

At sowing time sowings were made to test the effect of the following factors on the extent of germination. (All tests were made with fuzz derived from arrows of controlled crosses) :—

(1) Different lanterns;
(2) Time of flowering and consequently pollination, time of maturation and collecting;
(3) The region of the arrow from which the fuzz was collected; and
(4) The number of days elapsing between collecting and sowing.

When considering the effect of one factor all other factors were kept uniform. The effects were judged by the number of seedlings germinating per box and the extent of each effect was measured by the mean number of seedlings per box over a varying number of boxes.

Space precludes the possibility of entering the tables here and only the conclusions from the results are given :—

(1) *Different lanterns.* ..

There was considerable variation between the germination capacities of fuzz from different lanterns. This is probably due to differences in atmospheric conditions between the lanterns, especially temperatures and humidities as these effect pollen germination, fertilisation and embryo development and also as they effect the incidence of fungus attack. In this respect the number of arrows in any lantern next season will be reduced from four to two.

(2) *Time of flowering and consequently pollination, time of maturation and collecting.*

Fuzz derived from arrows flowering, being fertilised and maturing earlier in the arrowing season (up to about the end of November) gave germinations far in excess in numbers over those collected after this date. In practice therefore it were better to carry out crossing work as early in the arrowing season as is convenient (c.f. also higher pollen sheds early on in the arrowing season).

(3) *The region of the arrow from which the fuzz was collected.*

No significant differences could be established in the extent of germination shown by fuzz collected from the top, middle and bottom portions of the arrows and it is not thought likely that any increased numbers of seedlings can be got per unit of fuzz sown by sowings from any particular portion of an arrow.

(4) *The number of days elapsing between collecting and sowing.*

Results varied somewhat under this heading. It can be maintained, however, that delays beyond twelve days after picking before sowing tend to decrease the germination capacities of fuzz samples to a great degree. The optimum time for keeping appears to be around five to nine days.

These experiments will be repeated next season.

(*c*) SUGAR CANE SEEDLINGS 1930—FIRST YEAR SEEDLINGS.

The seedlings as usual were pricked out from the boxes into pots and the latter placed in the concrete cisterns. Only vigorous box seedlings were taken at this stage. All abnormally coloured plants and weak growers were rejected.

In all approximately sixteen thousand were potted with the aim in view of planting out six thousand. This excessive number potted was to allow for deaths and also to admit of populations from which to make selections of the more vigorous seedlings. That the latter is a justifiable measure is seen from experiments carried out in the 1929 and 1930 crops of 1st year seedlings.

This question of vigour in seedlings was further investigated in the cistern potted seedlings in 1930. It was desirable to know if (1) vigour in seedling "batches" in the potted stage and weight at crop time were correlated, and (2) if vigour in individual seedlings in any "batch" was correlated with their weights at crop time.

The method employed was as follows. Crosses of approximately similar potting dates were compared for vigour after about three months growth in the cisterns. For any one "batch" (collection of individuals from a definite cross) one hundred members were selected at random from its population in the cistern and the extent of development in the following features noted:— (1) number of tillers (2) development of tillers (3) length of leaves (4) width of leaves (5) length of pseudo-stem of mother shoot, and (6) width of the same pseudo-stem.

Now since these features are likely to be affected by (1) potting date and (2) position in the cistern, only "batches" of approximately equal potting dates were compared and only those whose positions in the cisterns were likely to be affected by the same conditions of environment.

Arbitrary values were given to the measured features and in each potting-date group one "batch" was selected to act as a standard for comparison and the mean figures obtained in its selected population for each measured character made to correspond to the arbitrary value.

Thus in potting-date Group I, Ba.11569 x B.H.10(12) was taken as the standard. The arbitrary values are here listed and the means for each feature of this particular cross.

Feature	Arbitrary Values	Ba.11569 x B.H. 10(12)—actual means of 100 plants.
No. tillers	30	2.61
Tiller development	20	30.00 mm.
Length of leaves	15	333.20 „
Width „ „	15	8.80 „
Length of pseudo-stem	8	110.00 „
Width „ „	12	4.26 „
Total	100	

Thus the vigour figure for this cross was evaluated at one hundred. Now, cross P.O.J.2364 x B.417 had its means determined for each feature in one hundred plants. These were:—

Feature	Actual means of 100 plants.	Computed vigour.
No. tillers	2.98	33.9
Tiller development	34.81	23.2 mm.
Length of leaves	379.79	17.1 „
Width „ „	10.70	18.3 „
Length of pseudo-stem	118.60	8.6 „
Width „ „	4.85	13.6 „
		114.7

The last column above was obtained by multiplying the vigour figure for each feature allocated to the standard cross in Group I, i.e. Ba.11569 x B.H. 10(12) by the value of the fraction obtained by dividing the mean figure for the cross by the corresponding figure in the standard.

From this data relative estimates for vigour were obtained for the crosses in any potting-date group. At the same time actual means for any feature were directly comparable between "batches" so that it was possible to note by examining the detailed figures how "batches" stood in relation to one another in respect of development of each of the features measured.

Correlations between each feature in "batches" at this time and at crop can be established as also for the hundred individuals of any "batch." The investigation has been conducted to determine whether such cistern "batch" measurement will in future reveal the future (crop time) possibilities of "batch" development. Thus if at any time a high number of crosses were potted and if it were found by this experiment that there was a significant high positive correlation between "batch" vigour (as obtained by this method) and, say, weight at crop time, then "batch" elimination or selection could be done in the cistern. This would admit of planting out a much larger number of crosses with the assurance that time, labour and field space were not being used for "batches" inferior in vigour in the cistern and consequently in weight at crop time, but which at present have to be tried out for a possible chance commercial cane. In other words, it is one further step on the part of the Department in making the breeding of sugar canes an accurate rather than an empirical science.

The growth vigour figures resulting for the batches are appended in Table II.

TABLE II.

RELATIVE GROWTH VIGOUR FIGURES OF SUGAR-CANE SEEDLING "BATCHES" SELECTED AT CODRINGTON DURING THE "POTTED" STAGE, 1930.

Potting Date.

8.1.30—14.1.30		16.1.30—24.1.30		5.2.30—7.2.30		10.2.30—13.2.30	
Batch.	Vigour.	Batch.	Vigour.	Batch.	Vigour.	Batch.	Vigour.
		P. O. J. 2364 x B. 605	151.6				
		Ba 11569 x B. 605	131.3				
		P. O J. 2725 x B. 606	122.5				
P. O. J. 2725 x B. 831 ...	115.9	P. O. J. 2364 x B. 606	122.3				
P. O. J.2364 x B. 417 ...	114.7	P. O. J. 2364 x B.H. 10(12)	116.1	P.O.J. 2725 x B.H. 10(12)	140.9		
P. O. J.2364 x B. 391 ..	106.3	P. O. J. 2725 x B. 374	106.1	P.O.J. 2379 x B. 374	136.1		
Ba. 11569 x B. 605 ..	105·7	Ba 11569 x Ba 6032	104.8	P.O.J. 2364 x B 391	121.3	Ba. 11569 x B. 391	122.4
Ba. 11569 x Ba. 6032 ...	102.5	Ba. 11569 x B. 606	102.9	Co. 213 x B. 374	114.2	Ba. 11569 x B. 605	102.8
Ba. 11569 x B. 606 .	102.0	P. O. J. 2725 x B.H. 10(12)	101.6	P.O.J. 2364 x B. 374	109.2	Ba. 11569 x B. 606	101.2
Ba. 11569 x B.H. 10(12)	100.0	Ba. 11569 x B.H. 10(12)	100·0	Ba. 11569 x B. 755	100.0	Ba. 11569 x B. 755	100.0
P.O. J. 2725 x B. 391 ...	97·8	P. O. J. 2364 x B. 374	96.5	P.OJ. 2725 x B. 606	91.6	Ba. 11569 x B. 831	95.1
Ba. 11569 x B. 391 ...	97·1	Ba. 11569 x B 417	93.0			Ba. 11569 x B. 417	82.6
Ba. 11569 x B. 374 ...	96·4	Ba. 11569 x B. 374	90.0				
Ba. 11569 x B. 831 ...	92·7	Ba. 11569 x B. 831	78.7				
Ba. 11569 x B. 417 ...	85·8						

A particularly interesting feature arising out of the above table is the greater vigor shown by the Barbados-Java crosses than by the Barbados-Barbados crosses.

The potted seedlings were planted out under irrigation when about four months old—in May 1930. Selection of the most vigorous plants was made in any "batch."

As with last year, so this year there were three groups—early, medium and late—and two thousand seedlings were planted out in each group.

In Table III are listed the "batches," their symbols and numbers allocated to each of the three groups.

TABLE III.

SUGAR CANE SEEDLINGS—CODRINGTON 1930.

SUMMARY OF "BATCHES" PLANTED OUT—THEIR GROUP ALLOCATION AND NUMBERS PLANTED.

"Batch." Parentage.	Symbol.	Group			"Batch" TOTAL.	Total.
		Early.	Medium.	Late		
	I. Both Parents Known.					
P.O.J. 2364 x B. 831	M. H.	7			7	
,, x B. 391	M. F.	150			150	
,, x B. 417	M. K.	40			40	
,, x P. 374	M. E.		150		150	572
,, x B H.10(12)	M. B.			150	150	
,, x B. 605	M. I.			25	25	
,, x B. 606	M. D.			50	50	
P.O.J. 2725 x B. 831	N. H.	60			60	
,, x B. 391	N. E.	200			200	
,, x P.H. 10(12)	N. B.		150	150	300	710
,, x B. 374	N. E.		100		100	
,, x B. 606	N. D.				50	
P.O.J. 2379 x B. 374	P. E.		50	50	50	50
Co. 213 x B H. 10(12)	S. B.			20	20	
,, x B. 374	S. E.			40	40	66
,, x B. 606	S. D.			6	6	
Ba. 11569 x B. 417	A. K.	150	100		250	
,, x B. 391	A. F.	150			150	
,, x B. H. 10 (12)	A. B.	350	350	250	950	
,, x B. 831	A. H.	200			200	
,, x B. 374	A. E.	200	100		300	3,400
,, x B. 755	A. G.	150	100		250	
,, x B. 606	A. D.		350	250	600	
,, x Ba. 6032	A. C.		100	250	350	
,, x B. 605	A. I.		100	250	350	
	II. Female Parent only Known					
P.O. J 2725	N.	60	60		120	
P. O. J. 2379	P.	20			20	
B. 891	L.	100	50		150	
B. 755	G.	100	50		150	
B. 606	D.		100	150	250	
B. 374	E.		100		100	
B.a. 6032	C.			150	150	
B. 605	I.			150	150	
B 417	K	100			100	
Total		2007	2010	1941		
Grand Total					5,958	

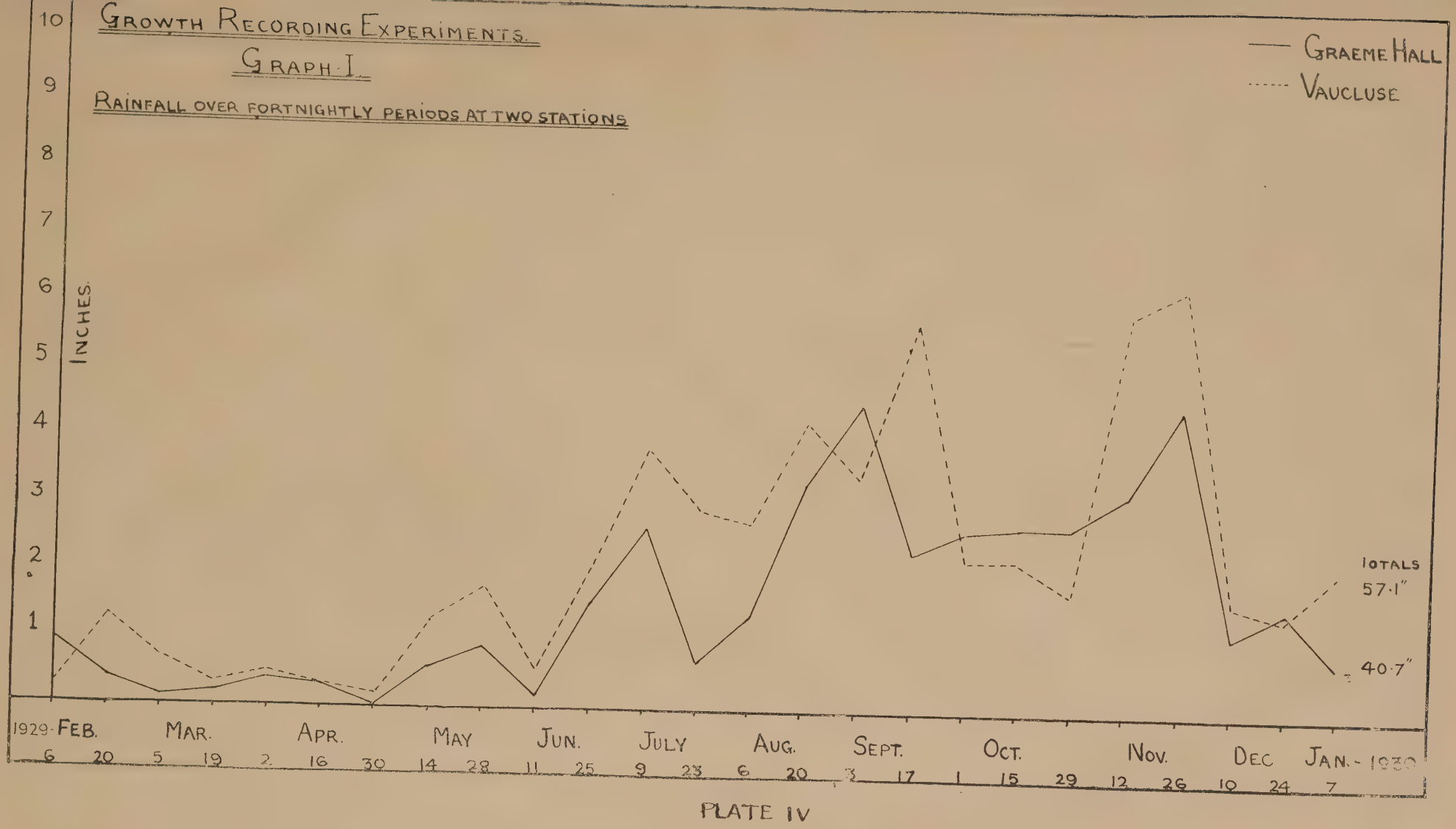
GROWTH RECORDING EXPERIMENTS.
GRAPH I.
RAINFALL OVER FORTNIGHTLY PERIODS AT TWO STATIONS
GRAEME HALL
VAUCLUSE
INCHES.
10
9
8
7
6
5
4
3
2
1
TOTALS
57·1"
40·7"
1929 FEB. MAR. APR. MAY JUN. JULY AUG. SEPT. OCT. NOV. DEC JAN. 1930
6 20 5 19 2 16 30 14 28 11 25 9 23 6 20 3 17 1 15 29 12 26 10 24 7

PLATE IV

In the 1928-29 report on page 38 is given a list of the field features noted for every seedling (1—8). Now any one of these eight features may be affected by position in the field so that for a comparison of seedling "batches" arrangement into blocks would not be satisfactory; for to get a sound mean for any "batch" (which, it must be borne in mind is constituted by individuals of different genotype), would necessitate a block of a minimum of at least sixty plants. Now place variation, (especially where quantitative features are concerned) is great (as has been proved in uniformity trails with sugar cane) and the experimental error is high.

Accordingly, all the seedlings in any group were randomised over the area of soil which it occupied. This is considered the most efficient lay-out which is possible under the circumstances and should give reliable relative estimations for field and factory features between "batches."

(*d*) SUGAR CANE SEEDLINGS.

1st Generation—Reaped 1930.

These seedlings were obtained from arrows at Lion Castle during the breeding season 1928 and planted out at Codrington under irrigation in May 1929. There were three groups—early, medium and late. The early group was reaped at the end of January, the medium at the end of March and the late in the second week of May.

The lay-out employed was the block system, which proved (as stated above) to be unsatisfactory.

The value of selecting vigorous seedlings in the cistern was again tested in these seedlings (c.f. 1928-29 Report, page 33, Table III).

This was done in the early and medium groups by comparing the mean weights per stool of comparable plots of cistern selected and non-selected "batches." This was Student's system of pairing. Plot details cannot be given in the report. The results were as follows:

Group.	Mean stool difference in favour of weight of selected over non-selected seedlings at crop time (pounds.)
Early	+ 4.33 ± 1.35
Medium.	+ 4.29 ± 1.61

These differences are statistically highly significant.

The result for the 1929 seedlings at crop time was +5.04 ±0.97 in favour of cistern selected seedlings.

The findings in 1930 corroborate the 1929 results and prove the efficacy of selecting the more vigorous seedlings in the cistern as a means of obtaining higher mean stool weights at crop time in the first year. Cistern selection will therefore be continued. Incidentally it was proved from an analysis of sucrose percentage data for seedlings from Ba. 11569 x B.H. 10(12) and Ba. 11569 x B. 391 crosses that cistern selection for vigour actually gave plants with a significantly higher sucrose percentage over non-selected. Twelve comparable blocks (6 each of the above crosses) had the percentage of sucrose in the juice of ten seedlings determined (i.e. for each block). The mean of the ten was obtained for any block and comparisons made. The following is the result—mean difference per stool in sucrose per cent in juice in favour of selected over non-selected seedlings + 0.78% ± 0.31% This difference is statistically significant. This point will be pursued in future, for the reverse result might have been anticipated.

The following parentages were included in these seedlings in one or more of the three groups—early, medium and late:—Ba.11569 x B.H.10(12),

Ba.11569 x B.391, B.381 x B.H.10(12), Ba.11569 x B.606, P.O.J.2364 x B. 606 and P.O.J. 2364 x B. 391. Seedlings from the following open arrows were also included:—B. 606, B. 391, B. 381, B. 374, B. 891 and Ba. 11569.

Summaries are given in Table IV for sucrose percentages and weights.

Each group is treated separtely and only "batches" of seedlings for which these features can be legitimately compared are set forth in the Table. For any feature distribution curves were drawn for the populations of each and every "batch" in order to determine the scope of these distributions and thus to note the extent of occurrence of extremes, for it is quite possible that the means for a particular feature in any two "batches." may approximate while their distributions are entirely different. These distribution curves cannot be reproduced here, but are being retained for reference.

From each group of approximately two thousand seedlings, twenty which were considered best were selected, making sixty selected seedlings in all. Cuttings were obtained from these and planted out in boxes, then put into the field under irrigation to give sufficient plants for extensive trials at the November 1930 planting (c.f. Ann. Rept. 1928-29 page 37) in high and low rainfall districts.

(*e*) CORRELATION EXPERIMENT.

In a first year seedling selection at reaping great emphasis is laid on the features contributing to the sugar per acre return, viz.: weight and sucrose percentage in the juice in any seedling. It is desirable to see in how far one is justified in laying emphasis on these all important features. Obviously if 1st generation seedlings are selected on these features and if the selection based on them is to be worth while, they (the features) must be retained over subsequent generations. Again, of the two features, which is the more stable (if either) over subsequent years? In an experiment (c.f. Ann. Rept. 1928-29, page 38, Table VI) correlation values for these features were obtained between the 1928 and 1929 crops, viz. weight +0.8371 and sucrose per cent +0.6218. The number of seedlings used for weight was only nineteen and it was thought advisable to repeat this experiment. Accordingly forty seedlings were selected from the 1929 reaping of 1st generation seedlings, to give a wide range in weights per stool. Their sucrose percentages were also determined. These seedlings were put into multiplication plots under irrigation during 1929 and in November were planted out. There were four replications—four blocks—and randomisation was made in each block. Each plot was of twelve stools. At crop in 1931, their weights and sucrose percentages will be determined and the correlations between the year of their selection as unit stools and their second reaping in 1930 (when they will each have forty-eight stools) will be determined.

Incidentally, it might be pointed out here, that it will be possible to establish correlations between any measurable feature in successive croppings in the sixty selected seedlings. It is proposed to carry this out in future work.

TABLE IV.

FIRST YEAR SUGAR CANE SEEDLINGS—REAPED CODRINGTON, 1930

Mean Weights and Percentages of Sucrose per stool.

PARENTAGE.	GROUP											
	EARLY.				MEDIUM.				LATE.			
	No.	Mean sucrose %	No.	Mean weight. (lb.)	No.	Mean sucrose %	No.	Mean weight. (lb.)	No.	Mean sucrose %	No.	Mean weight (lb.)
Ba. 11569 x B 391	120	14.68	321	33.02	76	18.33	214	27.30				
„ x B. H. 10(12) ...	113	15.38	331	35.86	82	18.21	219	29.29	72	18.92	179	27.67
„ x B. 606									29	18.15	64	25.06
P. O. J. 2364 x B. 391 ...									64	16.85	134	30.05
Ba. 11569	115	14.78	295	31.00	68	17.65	202	23.33	83	18.60	211	21 63
B. 891					60	18.45	173	20.09	79	19.13	184	18.03
B. 606									60	17.94	152	25.28
B. 374	108	14.77	237	28.50	70	17.40	207	23.20				

(f) EXPERIMENTS TO DETERMINE THE EFFECTS OF SEVERAL FACTORS ON VARIETAL GROWTH PHENOMENA THROUGHOUT THE GROWING SEASON AND ON COMMERCIAL FEATURES AT CROP TIME.

The degree of development of the features of commercial worth at crop time, viz. (a) weight and (b) sucrose in the juice, is chiefly dependent on (1) the variety (2) environment (in the sense of soil and climatic characteristics) and (3) the incidence of pests and diseases.

Now, weight and sucrose in the juice at any time in crop are, in any one variety, a resultant of the growth, its duration and amount, which has taken place.

It was necessary, therefore, to measure this growth in varieties at different places and to examine the weight and sucrose features at crop time.

The trial may, for convenience, be subdivided into two, viz. (1) growth recording and (2) weight and sucrose recording at crop. It is obvious that the causes and effects in both are of necessity linked together.

(1) GROWTH RECORDING.

The effects of three factors, viz. (1) variety (2) "place" and (3) moth borer on the amount of growth in time were studied. (The differences shown between "place" effects are chiefly due to differences in rainfall). Two places were selected for growth recording. Twenty stools—two in each of ten plots—of each of the following varieties were observed throughout the growing season, viz. Ba. 11569, B.H. 10(12), B. 417, Ba. 6032, B. 726 and B. 465. These were selected as giving a range of growth habit types in the Barbados canes. (This growth recording is being continued on the 1929-31 crop and includes Java varieties). Their growth was measured at fortnightly intervals from February 1929—January 1930. The total number of shoots present at any observation, together with the number of new shoots and the number killed by moth borer (this is the chief cause of death of shoots) were noted. Growth in length of shoots was noted for any stool by selecting, during February 1929, an average-sized shoot and marking it and noting throughout the growing season its length from the base to the youngest visible point where leaf blade meets leaf sheath. (This is the procedure adopted in Java and Louisiana). In September, in ten stools of each variety, a young or "c" shoot, was selected and the same method of growth recording made on it.

The two places are known as Vaucluse and Graeme Hall Plantations. The former is a station in the higher rainfall district while the latter is in the lower rainfall district.

It would be well at this point to consult the graphs presenting the data derived from these measurements. All points are the means for all varieties.

(*i*) *Rainfall Graph* (*Plate IV*).

From this graph it is seen that the total rainfall over the period of measurement is greater at Vaucluse than at Graeme Hall. At Vaucluse, moreover, precipitation is earlier and prolonged in more or less greater degree up to the final observations taken in January 1930.

(*ii.*) *Shoot Increments Graph* (*Plate V.*)

This shows for the earlier formed shoots (''a'' shoots) that, as with rainfall, so growth commences earlier at Vaucluse, reaches a greater intensity than at Graeme Hall, but despite high precipitations near the end of 1929, growth drops. At Graeme Hall growth, to any extent, commences later and only slowly increases. It is, however, prolonged in an amount greater than at Vaucluse towards the end of the year. The measurement of the late or "c" shoots reveals this growth vigour difference towards the end of the year at the two stations. The "c" shoots at Graeme Hall increase in length by leaps and bounds during October and November, while the "c" shoots at Vaucluse grow

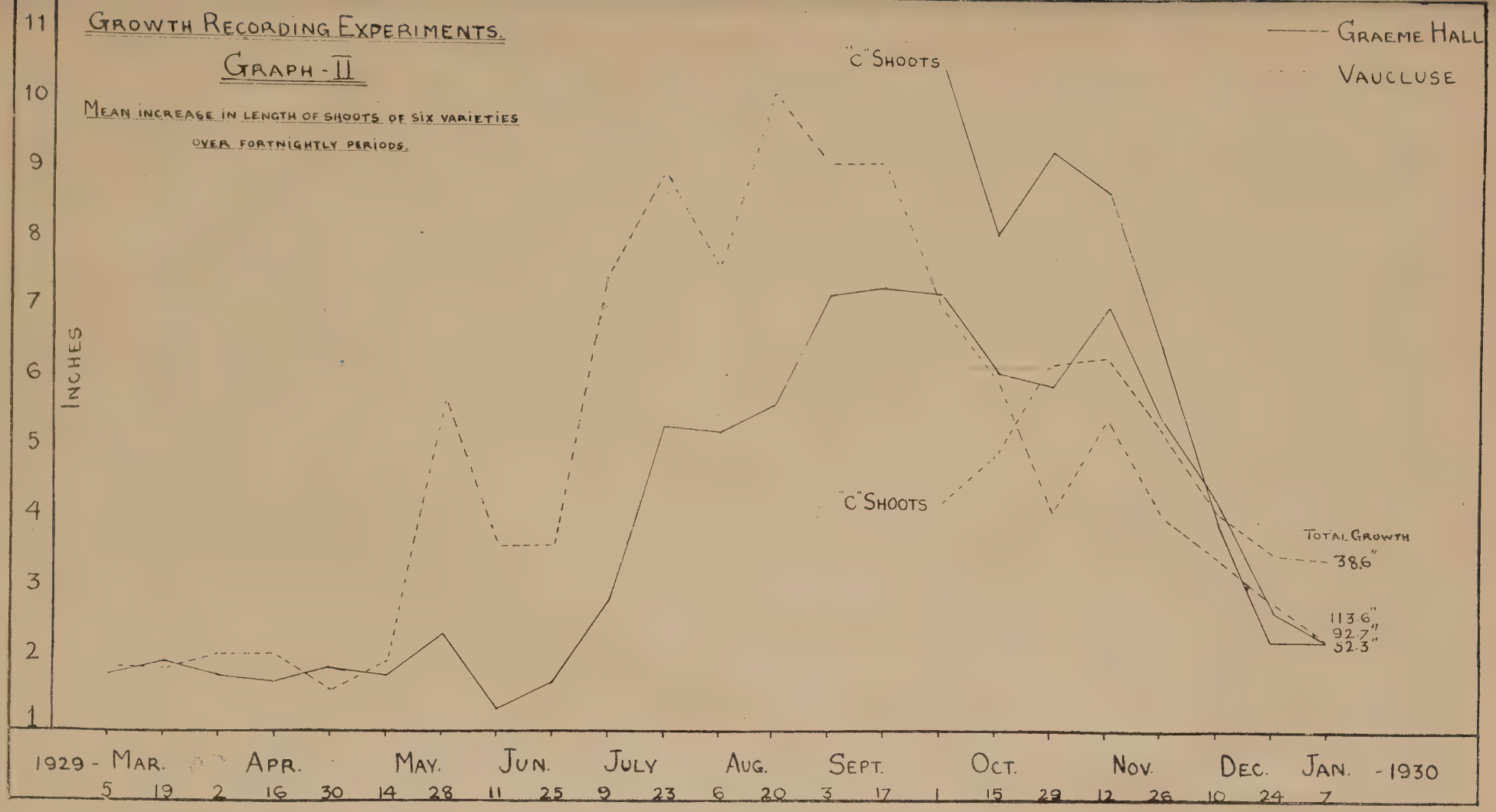
GROWTH RECORDING EXPERIMENTS.
GRAPH - II
MEAN INCREASE IN LENGTH OF SHOOTS OF SIX VARIETIES OVER FORTNIGHTLY PERIODS.
GRAEME HALL
VAUCLUSE
"C" SHOOTS
"C" SHOOTS
INCHES
11
10
9
8
7
6
5
4
3
2
1
TOTAL GROWTH
38.6"
113.6"
92.7"
52.3"
1929 - MAR. APR. MAY. JUN. JULY AUG. SEPT. OCT. NOV. DEC. JAN. - 1930
5 19 2 16 30 14 28 11 25 9 23 6 20 3 17 1 15 29 12 26 10 24 7

PLATE V

slowly and never attain the vigorous growth as seen at Graeme Hall. Graeme Hall growth period may be said to be at least nine weeks behind that of Vaucluse.

(iii). New Shoots Graph (Plate VI.)

New shoots are produced in comparatively small numbers at Vaucluse until the end of August, after which shoot production is almost negligible. At Graeme Hall shoot production is high during the first two months of the dry season—February and March—falls to a low figure towards the end of this dry period—May and June,—then. with the onset of the rains increases greatly until the end of September, after which time a small number of shoots are produced.

From Plates V and VI it is seen that growth (as indicated by shoot increments and shoot production) is much earlier at Vaucluse and falls off even during the months of good growing conditions near the end of the year. Plants at such a place may be said to enter into crop period in a sort of resting condition, whereas at Graeme Hall growth is prolonged right up to crop period, at which time the rains are going off.

(iv.) Total Number of Shoots Graph (Plate VII).

As a resultant of new shoot production at both stations, less the number killed by moth borer or dead, we note the total number of living shoots present at any time. This is seen to be greater almost throughout at the drier station, Graeme Hall, so that at crop the number of canes per stool at that station is in excess of the number at Vaucluse by about three per stool.

(2) THE RECORDING OF WEIGHT AND SUCROSE PERCENTAGE IN THE JUICE AT GRAEME HALL AND VAUCLUSE.

The growth recordings. noted above, were made in the same plots as were used for this experiment. The "lay-out" employed was the same at both stations. In all twelve varieties were used. All varieties were grown in each of twenty-four blocks and in each block were distributed at random. Each varietal plot in any one block consisted of nine stools.

At crop time, the yield and percentage sucrose in the juice were affected by:—(a) variety, (b) time of reaping and (c) place. Fifteen of the twenty-four blocks were selected, and were cut in three lots of five blocks each, each five for a different date. For any variety in any one block at any one cutting date, nine stools were cut and the canes numbered and weighed. The number of rotten canes were noted, but such canes were not weighed nor included in the sample bundles of canes sent to the mill for sucrose determinations. Each sample bundle weighed one hundred and twenty pounds made up of "a," "b," and "c" shoots, in numbers proportionate to their occurrence in the plot canes cut. The same was done for all twelve varieties in all five blocks at any one time and this was done on all three reaping dates, viz. February, March and May, making fifteen blocks in all cut. Detailed results will not be presented in this report but will appear in a paper to be published at a later date. The results are only summarised here.

The effects of (1) variety (2) time of reaping, and (3) "place" on the percentage sucrose in the juice will be considered. At the drier station, Graeme Hall, in February (i.e. beginning of crop) the average sucrose in juice over all twelve varieties was 16.6% with a range over varieties from 13.80%—19.10%; at Vaucluse, the rainier station corresponding figures were 15.00% and 12.00%—17.50%. At both stations there were rises by all varieties to the March reapings. At Graeme Hall the mean figure at this time was 18.75% (range 16.32%—20.86%), at Vaucluse 17.90% (15.75%—20.65%). The tendency at Graeme Hall was for the figures for varieties to drop towards the last reaping in May while at Vaucluse they continued to rise thus giving at Graeme Hall a mean of 18.45% (16.20%—20.32%) and at Vaucluse 18 60% (16.78%—20.33%).

An analysis of variance at Graeme Hall showed that different varieties and different reaping dates had a highly significant effect on the variation in the sucrose figure, and of these two causes dates of reaping had a greater effect than

the different varieties. It also showed that there is, on the part of varieties, a significant differential response in the sucrose percentages in their juices over the three reaping times.

Such an analysis at Vaucluse (the rainier station) showed that, as with the drier station, Graeme Hall, varieties and reapings had a highly significant effect on the sucrose percentage in the juice, but at this station the greater effect of the different reaping dates on the sucrose variation over that of the varieties was even greater than at Graeme Hall. Also it revealed the interesting point that in this experiment there was no differential response in sucrose in the juice by the twelve varieties examined over the three reaping times.

The effect of "place" on the sucrose figure was not considered statistically, but it can be deduced from the arithmetical means given above. This will be referred to later in a short discussion.

The effects of variety, date of reaping and "place" on the weight of canes will now be considered. (Only sound canes as would be sent to the factory, are considered here. Rotten canes will be considered later). At the drier station (Graeme Hall) the average weight for all varieties at first reaping in February was 433 lb. per plot of nine stools (range 381 lb.—491 lb.) while for the rainier station (Vaucluse) corresponding figures are 452 lb. (391 lb.—527 lb.) At second reaping in March the drier station gives a mean of 421 lb. (366 lb.—469 lb.) while the rainier 394 lb. (275 lb.—481 lb.) At the last or May reaping the drier station figures are 331 (302—427) and the rainier station 336 (243—441). At both places there is a drop in the weight of canes throughout crop, but it is of interest to note that the greatest drop at the drier station is between the second and third reaping, whereas at the rainier station it occurs between the first and second. At the former station there is a comparatively small drop in weight between first and second reapings, while the same holds for the rainier station between the second and third reapings. This is a highly important point and will be referred to later.

This drop in weight is referable to the extent of occurrence of rotten canes at both places. Rot is not apparent at the drier station between first and second reapings but is high between the second and third, whereas at the rainier station rot is very prevalent between first and second reapings but increases only slightly between the second and third.

The remaining or sound canes show an interesting feature in their individual weights which it is necessary to stress here as bearing on a later discussion. At the drier station, Graeme Hall, there is a definite increase in the weights of the individual sound canes between first and second reapings. Between second and third reapings some varieties drop while others still rise slightly. At Vaucluse, however, the individual cane weights tend to drop between first and second reaping and to retain or even increase their weights between second and third reaping.

Statistical analyses of weight returns at both stations show that there is a significant effect of varieties and reapings. In both cases reapings contribute a far greater effect to weight variations than varieties. At Graeme Hall, the drier station, there is a highly significant differential response by the varieties to the different reapings, but although there is an interaction between these at Vaucluse it is not a significant one.

A summary of these results for this experiment may now be made for each station.

I. At the drier station the sucrose in the juice rises to mid crop (mid March) and tends to drop towards the end of crop (beginning of May). The weight of canes is fairly constant to mid crop and then drops heavily to the end of crop. The number of rotten canes is small at the beginning of crop and at mid crop, but to end of crop increases to a great extent. The weight of the individual sound canes rises to mid-crop then, between varieties, rises slightly or falls to end of crop.

II. At the rainier station, the sucrose in the juice rises steadily (in sound canes) from the beginning to the end of crop, the greatest rise occurring between first and second reapings. The weight of canes is highest at commencement of crop, drops heavily to mid-crop, but is almost retained between mid-crop and end of crop. The number of rotten canes, comparatively high even at the first

reaping, increases in great amount to mid-crop and then is scarcely augmented by the end of crop.

III. Comparing the two stations it is seen that the sucrose in the juice is lower at the rainier station at the first reaping than at the drier, but rises almost to equal the drier station at mid-crop and actually excels the latter at end of crop. Weights are about equal at the beginning of crop but those at the rainier station drop to a comparatively greater extent at mid-crop, while at the final reaping the weights again are about equal. (This is referable to the occurrence of rot in time and amount at both places). It should be pointed out here that although (as was seen earlier) there are fewer canes at the rainier station at crop time, these canes are individually heavier than at the drier station and so weight returns are about equal at the beginning of crop at both places. The weight in time of the individual sound canes varies almost in the reverse direction at both places for while at the dry station it increases to mid-crop and may drop towards the end of crop, at the rainier station it decreases to mid-crop and rises afterwards.

Before proceeding to discuss the practical significance of the results of this experiment together with the growth recording, reference will here be made to another experiment run alongside the above and of necessity linked up with it.

The feature considered was the sucrose in the juice, and it was desired to ascertain whether the type of shoot had any effect on this. Thus four possible influential factors were studied, viz. (1) "place" (2) variety (3) time of reaping and (4) type of shoot ("a," "b," and "c.") These letters refer to the time of origin of the shoot (at crop time cane) and are not strictly of necessity the "a," "b," and "c" shoots of Barber. The latter investigator gave these terms to the shoots according as they originated in the plant—strictly an appellation with a morphological basis. The results, however, in all probability coincide to a considerable extent).

The nine plots remaining from the above experiment at both stations were used for this investigation. Six varieties only were used, and these were reaped at four times during crop., viz, 20th February, 3rd March, 14th April and 12th May. At any one crop time, for both "places" and one variety eighteen stools were cut (two from each of the nine plots). Each stool was treated as a unit. The "a," "b" and "c" shoots were separated, weighed and sent to the Laboratory for sucrose determination. (Owing to the small total number of stools for any variety no emphasis was laid on the effect of type of shoot on weight. This was done in the previous experiment and will be recorded in a special paper)

The results are summarised here. At the drier station reapings and varieties had a significant effect on the sucrose variation (reapings more than varieties—c.f. page 36) but the type of shoot had no significant effect.

At the rainier station, however, varieties and reapings had a significant effect and so also had the type of shoot.

The results of these investigations on the effects of these factors on varietal growth demand hypotheses to explain facts and these, as far as they can be advanced, have a practical significance in opening up new lines of study and investigation. They will be detailed in a separate paper along with detailed accounts of the experiments and statistical methods employed.

The following points of practical importance are detailed below.

In the account given the conclusions are given for the means of varieties for any particular feature. It may be stated at this juncture that there was generally a differential response of varieties in any feature to time of reaping and this was more especially the case at the drier station.

Now, at both stations it is seen that the all important features, weight and sucrose, vary during crop and that to a certain extent in opposite directions. Therefore, speaking generally for all varieties there is, for each place, an optimum period during crop, when the highest return of sucrose per acre is obtainable. In the earlier part of the reaping season the sucroses are low while towards the end of crop the tonnages drop to a considerable extent. The most profitable period for cutting is in between these two periods—from mid-March to mid-April. This of course is in factory practice impracticable. It is therefore necessary to improve, from the varietal point of view, these two periods—before and after the optimum period for all varieties. The problems are to obtain

varieties which give a higher sucrose earlier in crop especially in the rainier districts and to avoid, by varietal selection, an occurrence of rotting towards the end of crop in both districts. In other words, by seedling production and selection it is hoped to prolong the optimum period at any place. It is now proved that the policy advocated in the 1928-29 Report, namely, to produce varieties best suited to particular places for particular cropping times is the only one likely to produce the desired results. All breeding work is therefore being done along these lines and questions such as what is implied by maturity and what influences it and what causes canes to rot will be closely investigated.

With the commercial varieties on hand, and by adequate trials with these plants, data is accumulating which is aiding an assortment of these varieties into their ecological "niches" in the Island.

The aim is not now therefore to obtain the best variety for the Island, but rather the best varieties for particular places and particular times, for it is now definitely proved that no one variety is suited to be best over all places and all reaping times, as is shown by the differential response by varieties at places in their weight and sucrose to the progress of time in crop season.

It appears that, speaking generally for all varieties, there is a growing period, which is influenced in duration and extent by external growth promoting factors, especially rainfall (and consequent soil moisture content) and possibly manuring, (the extent of these and their times of incidence and of application). According as these vary in amount and time of occurrence, so growth of varieties is quickened or retarded, so that the ultimate growth expression may be hastened or slowed down, increased or diminished.

Such growth, in duration and amount, whether greater or less according to variety, "place" and treatment, ultimately falls off and for a shorter or longer period (again influenced by the same factors) is negligible. This is a period of vegetative inactivity, and it must be stressed here that this may occur even under very good environmental conditions for growth (c.f. November and December growth at Vaucluse—Plates IV and V) and is in all probability a varietal character of the plant; its first cycle is over and it is resting until the time comes when growth is renewed. Probably this is a function of the root-growth cycle. The point of immediate practical importance is that this resting period in the plant seems to be of such a nature that well formed canes may very readily rot and such rot is influenced in amount by certain conditions, such as extreme dry or wet conditions during this period. Canes rot early at the rainy station; growth here is completed early and heavy rains continue to fall on a resting plant. Canes rot late at the drier station; growth here runs into crop, ceases, then extremely dry conditions obtain towards end of crop.

From various findings it appears growth recommences (second growth or ratooning) in greater or less degree in the rainier district towards mid-crop. Hence little or no further rot occurs after this. At the drier station first growth ceases about beginning of crop and rot sets in about mid-crop.

So far it cannot be seen that there is any necessary relationship between the vegetative growing period and the period of high sugar in the juice. At the rainier station first growth is over and done with earlier than at the drier station, yet sucrose reaches its highest point earlier at the drier station. Sucrose percentage would appear to be influenced rather by the amount of moisture in the soil. So long as this is high, so the juice quality will be low.

(*g*) VARIETY TRIALS AND PLANTING RECOMMENDATIONS.

The results of these trials are derived from reapings in 1930. They were laid down in November or December, 1928. At any one station there were twelve varieties in each of six randomised blocks. Each variety plot comprised twenty-five stools and from each plot, at reaping, twenty normal stools were cut and weighed. At any station, for any variety, a representative bundle of canes weighing thirty pounds was taken from each of the six plots—in all, for any variety, a one hundred and eighty pound sample. The samples from all stations were completely analysed at the Laboratory.

There were in all thirteen trials, eight of which were devoted to plant canes and the remaining five to first ratoons. These are dealt with separately.

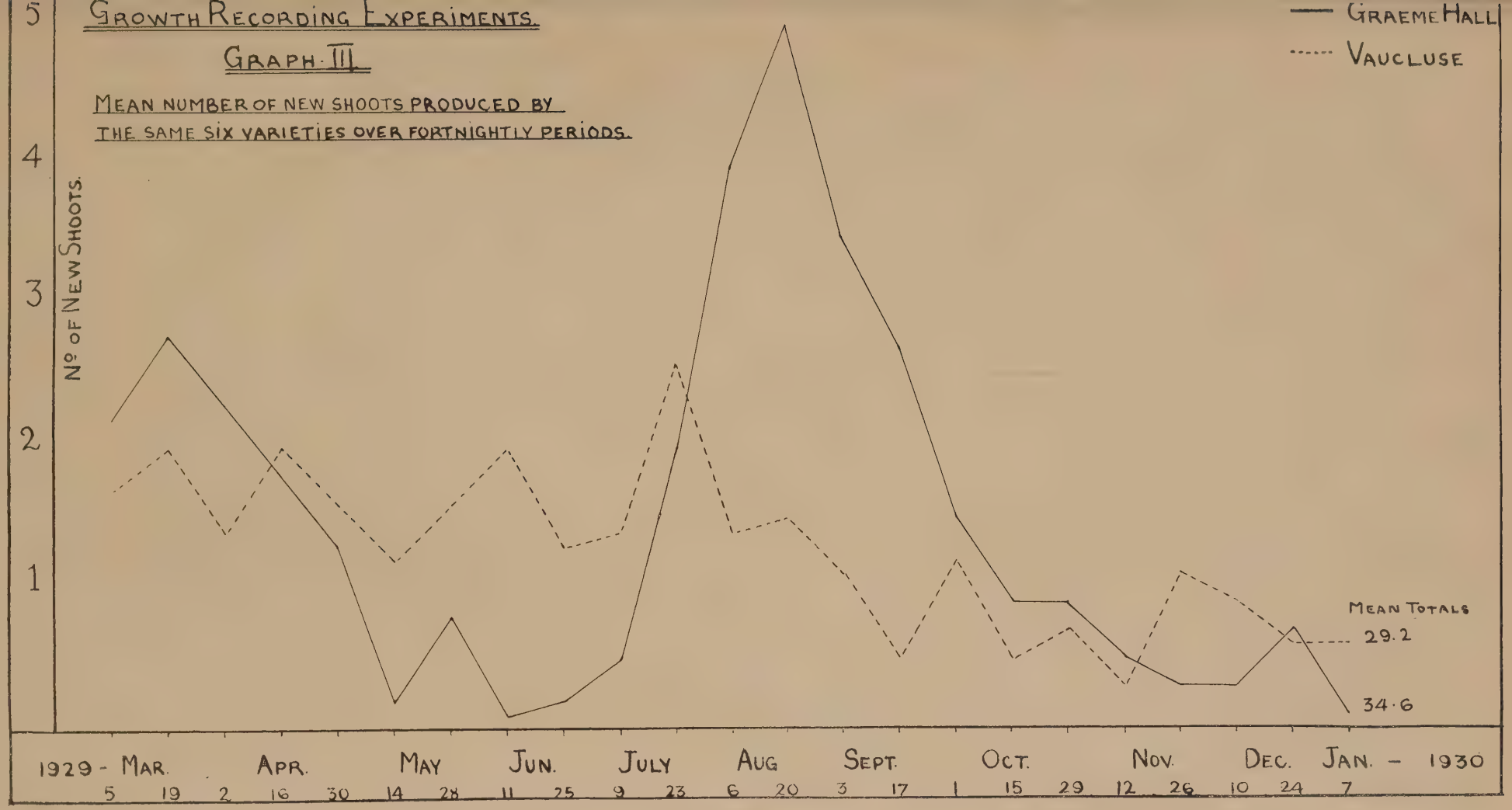
GROWTH RECORDING EXPERIMENTS.
GRAPH. III.
MEAN NUMBER OF NEW SHOOTS PRODUCED BY THE SAME SIX VARIETIES OVER FORTNIGHTLY PERIODS.
GRAEME HALL
VAUCLUSE
Nº OF NEW SHOOTS.
5
4
3
2
1
MEAN TOTALS
29.2
34.6
1929 - MAR. APR. MAY JUN. JULY AUG SEPT. OCT. NOV. DEC. JAN. - 1930
5 19 2 16 30 14 28 11 25 9 23 6 20 3 17 1 15 29 12 26 10 24 7

PLATE VI

I. Plant Canes.

There were eight stations for plant cane trials, but these were divided into two lots of four.

Two groups of varieties were tried out, one of each to four stations. Thus:

Group I.	Variety.	Place.
	B.H. 10(12), Ba. 11569, B. 726, B. 374, B. 391, B. 606, B. 702, B. 755, B. 663, B. 793 and others.	Mt. Wilton, Ridgeway, Warleigh, Coverley.
Group II.	B. H. 10(12), B. 726, B. 381, B. 417, B. 465, B. 605, B. 763, B. 831, B. 891 and others.	Blackmans, Lears, Clifton Hall, Pickerings.

B.H. 10(12) occurred in each group at two stations only.

Owing to shortage of labour the cutting of varieties which were obviously inferior in the field at crop time, was omitted.

It is considered that the following factors are chiefly responsible for affecting the sugar per acre return:—(1) time of reaping (2) "place," and (3) variety. (The effect of pests such as moth and root borers cannot be considered here).

It has been proved by experiments already detailed that there is interaction between these factors.

From the nature of the variety trials' "lay-out" only four stations were comparable for any one group of varieties. In any group, moreover, the places were different and the times of reaping, so that for varietal comparisons in any group, one station alone could be used. At any one station, moreover, the plots were only of twenty stools.

For the future the size of plot at any one station will be greatly enlarged, moreover, cutting at any one station will take place at two periods in crop and the times of cutting at different stations will be as near to one another as possible. By this method it should be possible to determine the effects of (1) variety, (2) time of cutting, and (3) "place" on the yield of sugar per acre, to determine whether there is any interaction between these factors and to ascertain which varieties are most suited to particular times of reaping.

There has been no attempt to estimate the differential response (if it exists) by varieties to different places and different reaping times, nor was it considered profitable to examine the results statistically. The results are presented in diagramatic form (Plates VIII-X) and general deductions are made from these plates.

The information derived from the maturity experiments was incorporated to provide recommendations made to planters.

II.. First Ratoons

There were five trials reaped as first ratoons. Again there were two groups. Thus:—

Group I.	Variety.	Place.
	White Transparent, B.H. 10(12) Ba. 11569, B. 381, B. 417, B. 465, B. 605, B. 831, B. 891.	Ridgeway. Blackmans.
Group II.	White Transparent, B.H. 10 (12) Ba. 11569, B. 381, B. 417, B. 374, B. 391, B. 663, B. 726, B. 755, B. 606.	Lemon Arbor, Buckden and Mt. Wilton.

The results are presented in diagramatic form (Plate XI).

From these trials and the information from the maturity experiments the following recommendations are made.

Region I. This is the region of higher and more prolonged rainfall where B.H. 10(12) is definitely known to yield successfully.

Two varieties only are recommended for this region, viz. B. 726 and B.H. 10(12) and the acreage should be equally divided between those two varieties. B. 726 should be reaped first and then followed by B.H. 10(12).

These are recommended for the following reasons. Both have proved to be good ratooning canes. B.726 gives a high tonnage and at beginning of crop (and indeed throughout crop) has on the average a higher sucrose percentage in the juice than other varieties tried in these ,districts. It tends, however, to rot considerably after mid-crop and herein it must give way to B.H. 10(12) which by this time has attained a high sucrose percentage in the juice and is not nearly so prone to rotting. Both, incidentally, are good germinators.

Other varieties may approach the above at times but are not expected to perform so consistently high as either of them. B. 381, while giving at times a good tonnage is a bad germinator, rots to an appreciable extent, and is lower in its juice quality than either of the above. B.605 cannot be considered fit to replace either of the above on account of its poor germination and comparatively low quality juice. B.755 may, after further trial, suggest itself as a late variety to occupy part of the B.H.10(12) acreage, but for the present it is not recommended.

B.374 is disappointingly average in tonnage and juice quality. Ba.11569 should not occupy a place in this rainy region on account of its pronounced tendency to rot and its comparatively poor juice, while varieties like Ba.6032, B.663, B.606, B.417 and B.465 are beyond the possibilities of consideration for this region.

Region II. This region embraces the drier parishes of St. Philip, Christ Church, most of St. Michael, the lower and drier areas in St. George, the coastal belt of St. James, St. Peter and practically all of St. Lucy's parish.

No variety so far has been evolved which can retain its tonnage or its optimum juice quality until the end of crop in this region.

The following varieties are considered suitable for this region:—B.726, B.891, B.831 and Ba.11569. It is recommended that the acreage planted to Ba.11569 should be greatly restricted and priority given to B.891 and B.831. Both these canes tend to give a higher tonnage and have better quality juices than Ba.11569. The latter moreover appears to be uncertain in its performance from place to place. In our variety trials this year it fluctuated in the merit lists at plantations from top to bottom. B.891 and B.831 were consistent in their performances.

B.726 early on in crop had a very high quality juice and good tonnage. While retaining its high juice quality till end of crop, its tonnage, however, tended to drop.

Ba.6032, B.606 and B.663 should no longer be planted on account of their very low quality juices. Moreover, Ba.6032 and B.606 are poor tonnage canes when compared with the above four varieties.

B.374, B.391, B.417, B.605, B.465, and B.381 are border line cases and will not be recommended until further trials have been made on them.

The following recommendations are made for this region. The varieties are given in the order to be adopted at reaping and in brackets after each the fraction of the total acreage to be planted:—B.726 (3/8), Ba.11569 (2/8) and B.891 or B.831 (3/8).

Region III. This may be called the "transitional region" and represents an area in which the rainfall wavers from season to season between an amount sufficient or insufficient for a successful growing of B.H.10(12).

Such regions occur along the bottom of the ridge running parallel with the seacoast by Blowers, Ridgeway, Lancaster and Whitehall. Again it may be said to occur on the Eastward side of St. John's parish, in the transitional belts in St. Michael and St. George between the drier and wetter areas (Regions I and II respectively) and also at the bottom of St. Andrew's parish around Belleplaine.

In such districts the following varieties are recommended:—B.726, B.H.10 (12), B.891 or B.831 and Ba.11659. Their proportions of the total acreage to be planted are given here and they are listed in order of their reaping at crop time:—B.726 (¼), Ba.11569 (¼), B.891 or B.831 (¼) and B.H.10(12) (¼).

(*h*) SPACING EXPERIMENT IN SUGAR-CANE.

No experiments on the effect of different spacings on the yield of sugar cane have been reported on in recent departmental reports and the object of the present experiment is to obtain information on the effect of different planting distances on yield (tonnage). It was considered that different varieties, on account of their different above ground and also rooting habits, might respond differently to different spacings. Since nothing is known of rooting habits of Barbados canes in Barbados three varieties were selected to represent three different habit types of the above ground parts, viz., B.891, B.H. 10(12) and B.605. Three spacings are employed, viz., 6′ x 5½′, 5′ x 5′ and 5′ x 2½′. Cane holes were dug for the first two spacings while for the third furrows were opened at 5′ intervals and cane plants inserted in them at 2½′ apart. Each of the three varieties was planted at the three different spacings, making in all nine "treatments" for any block. In any block all nine "treatments" were randomised. There are four blocks (replications). It is hoped to obtain the effect of (1) spacings employed and (2) varieties, on yield and to observe if there is any differential response of the three varieties to the different spacings. These canes will be reaped in the 1931 crop season.

SECTION II. SWEET POTATO.

INTRODUCTION.

Speaking generally for all varieties of sweet potato, the yield rises with increase in duration of the growing period. The highest possible yield from any variety can only be obtained if that variety is allowed the time and the conditions to express itself fully.

The chief limiting factors to full growth expression in Barbados are (1) the duration of the growing season (2) the presence of scarabee, making necessary early lifting (3) the scantiness of the rainfall during certain growing periods and (4) the use of varieties for a "short" crop which require a long growing season.

In all cases it is necessary, for a good establishment of plants, to plant slips in the rainy season. (This refers to non-irrigated soils). In land which is being brought into canes in the November of the same rainy season, planting must be done early in the rains i.e. about July. This allows a growing season of fourteen to sixteen weeks. All plants are dug about the end of October or beginning of November in order to leave time for preparing the land for sugar cane. Since this is necessary for all "catch" crop potatoes and again since such a system is fairly common in Barbados, there is a tendency at this time for over production with a consequent glut, low prices, and even waste.

It is necessary to obtain for potatoes dug at this particular time a higher demand and so better prices.

It is not likely that the demand could be made to increase within the Island, so that, if sweet potato growing as a "catch" crop is to be profitable an immediate export trade must be obtained at that time, or else such potatoes must be suited to storage in the Island to serve for supplies at a later date when the need for them is greater. So long as scarabee is present in certain areas, shipping or storing would be impracticable (since scarabee spreads in storage). It might be necessary to restrict the acreage of "catch" crop sweet potato lands in scarabee districts to such a size that the crop from it could be fully used at the time for local consumption at a remunerative price to the grower. Now, for "catch" crop lands in non-scarabee areas, it would be desirable to grow for local storage or export.

In either case varieties which produce in a short time high yields of potatoes of good eating quality are desired with the further necessity for non-

scarabee areas of good keeping qualities in order to admit of storage or transport.

The other system of sweet potato growing is cropping in "thrown out" land. Planting is done any time during the rains and lifting from January onwards.

It might be possible to store "catch" crop potatoes until February and then follow on with supplies from "thrown out" land. Storage of these could be done to serve for the storage period from June until September, i.e. before the "catch" crop potatoes are available. Storage, again, could be done with potatoes from areas free from scarabee, while potatoes in districts where scarabee is present could be lifted and sold for immediate consumption or export. The aim of the investigations by the Department is to breed varieties of potatoes so that a steady and adequate supply of sweet potatoes may be maintained throughout the year at a fixed and remunerative price to the growers with a surplus for export.

Even the most perfect marketing system demands varieties for short and long crops. Both types should be designed to give, under their respective conditions, high yields of good eating potatoes. Varieties must also be obtained for keeping in the ground or in storage or in transport (this refers to non-scarabee areas). Thus:—

AREAS.

SCARABEE-INFESTED LAND.		SCARABEE-FREE LAND.	
I	II	III	IV
"Catch" Crop	"Thrown-out" Land	"Catch" Crop	"Thrown-out" Land
(1) High yield in short time	(1) High yield under drier conditions	(1) High yield in short time	(1) High yield under fairly dry conditions.
(2) Good eating quality	(2) Good eating quality	(2) Good eating quality	(2) Good eating quality
		(3) Good keeping quality	(3) Good keeping quality

These four categories are quite distinct, since it is possible that a potato suited to I may not have the good keeping qualities necessary for III. This is common in Barbados plants c.f. the variety "Six Weeks." The same difference holds between II and IV.

As was indicated in the Report of the Department for 1928-29 the problems from the varietal point of view are being attacked along two lines. Firstly, local and imported varieties are being tried and secondly seedlings have been produced and are being selected to a manageable number to compete against the best varieties in each of the aforementioned categories.

VARIETY TRIALS.

There were two variety trials carried out, viz: (1) a "short" crop and (2) a "long" crop. The object for each was to determine the relative merits of the varieties used in yield, eating quality and storage ability.

The "short" crop trial was conducted at Codrington Experimental Station. There were twenty-seven varieties. All were randomised in each of six blocks (replications). Each variety plot consisted of twenty-four hills (two hills per hole) and a cane hole width was left between any two variety plots. The plants were planted on August 20th 1929 and reaped December 10th, 1929.

Table I shows the results.

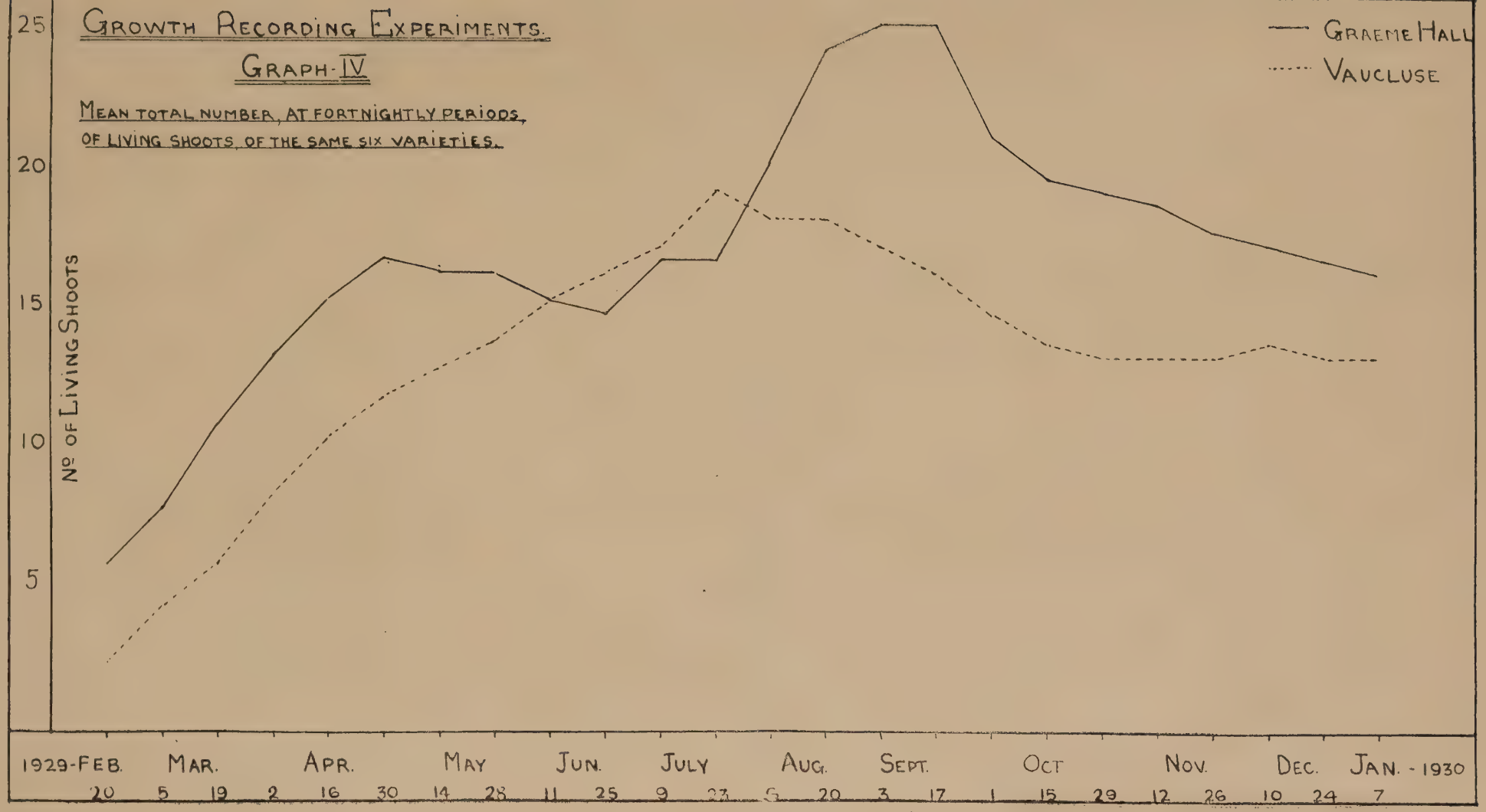
GROWTH RECORDING EXPERIMENTS.
GRAPH-IV
MEAN TOTAL NUMBER, AT FORTNIGHTLY PERIODS, OF LIVING SHOOTS, OF THE SAME SIX VARIETIES.
GRAEME HALL
VAUCLUSE
No OF LIVING SHOOTS
25
20
15
10
5
1929-FEB. MAR. APR. MAY JUN. JULY AUG. SEPT. OCT NOV. DEC. JAN. - 1930
20 5 19 2 16 30 14 28 11 25 9 23 6 20 3 17 1 15 29 12 26 10 24 7

PLATE VII

TABLE I.

SWEET POTATO VARIETY TRIAL—"CATCH CROP"—SIXTEEN WEEKS GROWING SEASON—CODRINGTON, 1929.

Name.	Country of Origin.	Mean Yield in lb. per plot of 24 hills.	A. Rejected for inferior yield and /or appearance.	B. Rejected for poor eating quality before storage.	C. Good flavoured cookers after four months storage. (In order of merit).	D. Rendered by scarabee unfit for eating after four months storage.
Red Nut	Local	50.5				D.
V.52	St. Vincent	48.5				
Six Weeks	Local	41.0				D.
Brook's Gem	Australia	40.7			C.1	
Brook's Seedling No. 3 ..	„	37.0			C.4	
Southern Queen	U.S.A.	34.8		B.		
Brook's Seedling No. 29 ..	Australia	34.7			C.3	
Purple-stemmed Six Weeks ..	Local	28.3				
White Gilkes	„	26.6		B.	C.5	
Caroline Lee	„	25.5				
Trinidadian	„	23.7			C.2	
Orange Hill	„	23.0		B.		D.
Freshwater	„	19.3	A.			D.
Hall's Seedling No. 1	„	18.7	A.			D.
Pumpkin Yam	U.S.A.	18.3				D.
White Sealy	Local	18.3		B.		
Yellow Jersey	U.S.A.	17.5	A.			D.
Brook's Seedling No. 60 ..	Australia	17.3		B.		
„ „ No. 6 ..	„	14.0				
Nancy Hall	U.S.A.	11.6	A.			
St. Joseph Water Hole ..	Local	6.6	A.			

TABLE I.—(*Continued*).

SWEET POTATO VARIETY TRIAL—"CATCH" CROP—SIXTEEN WEEKS GROWING SEASON—CODRINGTON, 1929.

Name.	Country of Origin.	Mean yield in lb. per plot of 24 hills.	A. Rejected for inferior yield and /or appearance	B. Rejected for poor eating quality before storage.	C. Good flavoured cookers after four months storage. (In order of merit).	Rendered by scarabee unfit for eating after four months storage.
Hug-meTight	St. Kitts	6.5	A.			D.
Hall's Seedling No. 2	Local	5.6	A.			
German	„	4.4	A.			D.
Todds	St. Kitts	4.3	A.			
Bourbon	Local	2.8	A.			D.
Bequia	„	1.3	A.			

Statistical Notes: An analysis of variance reveals a highly significant effect of variety on yield. A difference between variety means for 24 hill plots of ± 11.06 lb. indicates that such a difference has a 20:1 chance of being due to a varietal difference.

The percentage standard deviation in this experiment was high.
Attempts will be made to lower the experimental error by
(1) reducing the number of varieties
(2) increasing the number of holes per variety per plot;
(3) by attempting to get a good and uniform take, by planting two slips per hill;
(4) by endeavouring to plant for all varieties slips of uniform appearance; and
(5) by planting the blocks in the experimental land of size and shape likely to contain the least possible soil variability within each.

COOKING AND STORAGE TESTS.

For cooking tests, three medium sized sound potatoes were selected and cooked. Notes were made on the cooked potatoes on flesh colour, texture, consistency and sweetness. Tasting was done by impartial persons and their judgments were noted.

Storage was effected in wooden crates whose sides were made of laths. These crates were raised about two feet from the ground. They were situated in a place protected from the sun's rays and admitting adequate ventilation.

During storage notes were made on sprouting, drying and rotting. Sprouting and perhaps drying were considered to be varietal features. Rotting was mainly due to severe scarabee infestation. (Incidentally this storage trial showed how impossible it is to store crops from scarabee infested land; for despite the fact that these potatoes were hand picked at lifting to admit only scarabee-free ones into storage, a few infested ones must have passed examination. Scarabee bred in the crates from this infected material and spread in amount proportionate to the duration of storage).

A second cooking test was made on the 14th April, 1930 (approximately four months storage).

The majority of the potatoes tested were either of a very dry or a watery consistency.

It is of interest to note the appearance of three out of five of Brook's Seedlings from Queensland, Australia. These seedlings yield well and some are of a very good cooking quality. With their good keeping ability they promise well.

The "long" crop was planted at Applewhaites on 5th November, 1929, and lifted on 23rd April, 1930—a growing season of approximately twenty-four weeks. Twenty-one varieties were planted—the following included in the "catch" crop being eliminated:—Bequia, Bourbon, Hall's Seedlings Nos. 1 and 2, Freshwater and Orange Hill. The "lay-out" was the same as that of the "catch" crop.

The yields are given here in Table II.

TABLE II.

SWEET POTATO VARIETY TRIALS.—"LONG" CROP—APPLEWHAITES. TWENTY-FOUR WEEKS GROWING SEASON.

Varieties are in order of yield. The latter is expressed for any variety as the mean yield per plot of twenty-four hills.

Name.	Country of Origin	Yield lb.	Statistical Notes.
Brook's Seedling No. 3 ..	Australia	75.25	An analysis of variance reveals a highly significant effect of variety on yield. A difference between variety means of ± 12.90 lb. indicates that such a difference has a 20:1 chance of being due to a varietal difference.
St. Joseph Water Hole ..	Barbados	70.50	
Purple Stem Six Weeks ..	„	67.00	
White Gilkes	„	66.54	
Six Weeks	„	65.16	
Red Nut	„	58.10	
V.52	St. Vincent	57.67	
Brook's Seedling No. 6 ..	Australia	52.50	
„ „ No. 60 ..	„	51.30	
Caroline Lee ..	Barbados	47.00	
Hug-Me-Tight	St. Kitts	42.30	
Brook's Gem	Australia	41.90	
Todds	St. Kitts	41.00	
White Sealy	Barbados	40.10	
Trinidadian	„	37.00	
Southern Queen ..	U.S.A.	36.10	
Brook's Seedling No. 29 ..	Australia	35.20	
German	Barbados	31.30	
Pumpkin Yam	U.S.A.	28.00	
Nancy Hall ..	„	21.70	
Yellow Jersey	„	17.30	

The average yield is higher in the "long" than in the "catch" crop.

Brook's Seedling No. 29 and Brook's Gem have dropped relatively from their high position in the "short" crop. They may perform best (relative to other varieties) as "catch" crop potatoes. Again it is of interest to note the comparatively poor performance of Trinidadian (Black Rock) in both "catch" and "long" crops.

These trials have been of value in revealing yielding capacity tendencies in the varieties, cooking qualities and keeping abilities.

It would be premature to make recommendations as a result of these trials, but these results admit of cutting the number in future trials and increasing the size of the individual variety plots. The following varieties were chosen and planted at Codrington under irrigation during the dry season. Slips will be obtained from these plants for a "catch" crop trial and slips from plants in the latter for a "long" crop trial:—

Red Nut V 52, Six Weeks, Brook's Gem, Brook's Seedling No. 3, Brook's Seedling No. 29, Brook's Seedling No. 6, Purple Stem Six Weeks, White Gilkes, Caroline Lee, Trinidadian, Philippine Seedlings Nos. 1, 2 and 3 and St. Joseph Water Hole.

SWEET POTATO SEEDLINGS.

As seen in the Annual Report of this Department for 1928-29, seedlings were planted out each in a single hill to a hole (an area of 25 sq. ft.).

For headings for data on individual performances, Brook's Sweet Potato Classification Scheme was used (See Brooks, G.B. 1923, "The Sweet Potato," Queensland Agricultural Journal, XX, Part 2).

The sweet potato seedlings were planted out under irrigation in April, 1929. Water was applied once a week for three weeks and then once on 10th June. Lifting was done in July giving a growing period of approximately fifteen weeks.

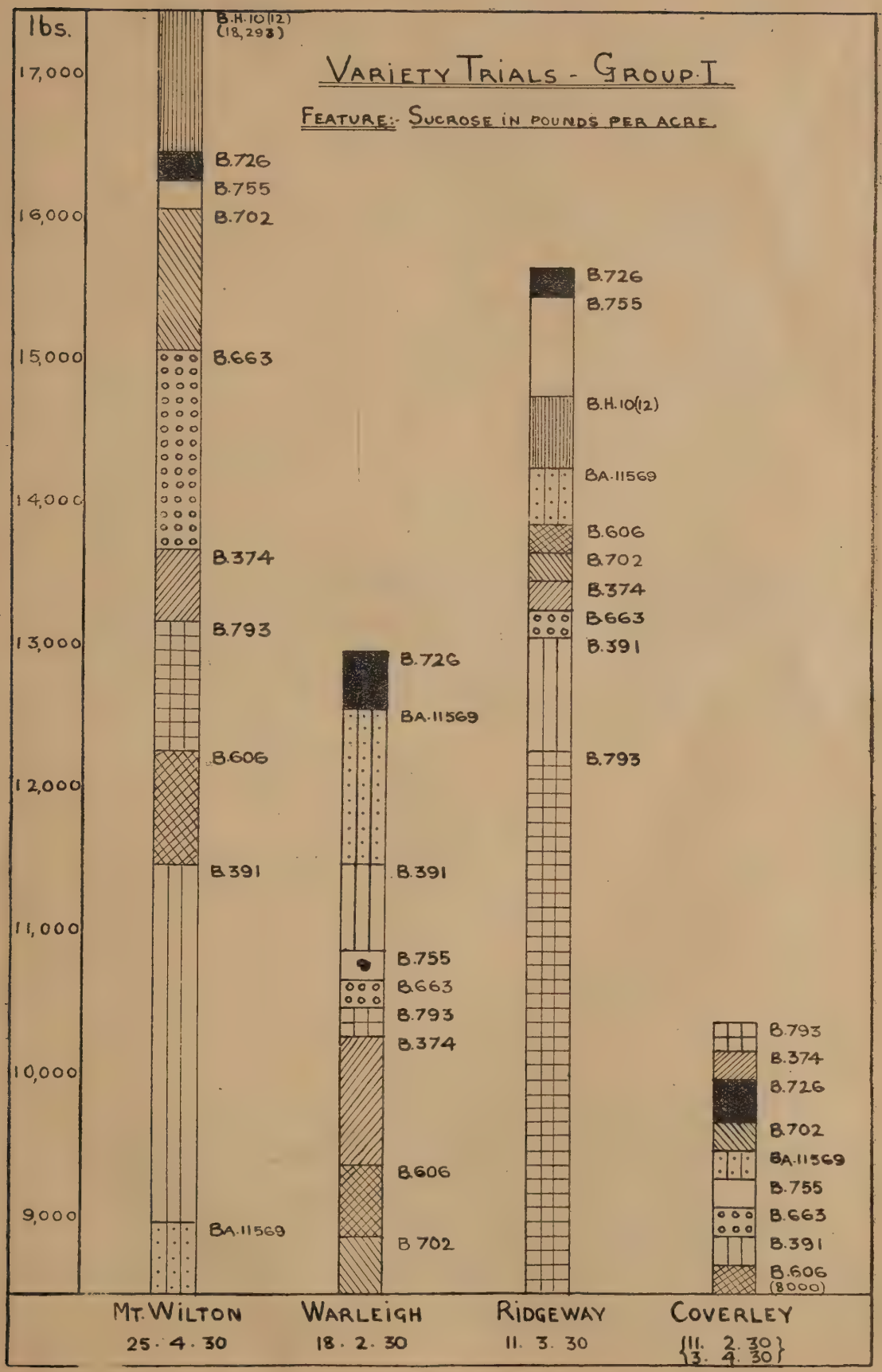
lbs.
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
VARIETY TRIALS - GROUP I.
FEATURE:- SUCROSE IN POUNDS PER ACRE.
B.H.10(12) (18,293)
B.726
B.755
B.702
B.663
B.374
B.793
B.606
B.391
BA.11569
B.726
BA.11569
B.391
B.755
B.663
B.793
B.374
B.606
B 702
B.726
B.755
B.H.10(12)
BA.11569
B.606
B.702
B.374
B.663
B.391
B.793
B.793
B.374
B.726
B.702
BA.11569
B.755
B.663
B.391
B.606 (8000)
MT. WILTON
25 · 4 · 30
WARLEIGH
18 · 2 · 30
RIDGEWAY
11. 3. 30
COVERLEY
{11. 2. 30
{13. 4. 30}

PLATE VIII

The following features were noted for all at lifting:—

(1) Habit;
(2) Depth of potatoes in ground:
(3) Shape of potatoes;
(4) Number of potatoes;
(5) Colour of flesh;
(6) Thickness of skin;
(7) Smoothness of skin, and
(8) Weight of potatoes.

Selection was based on features under headings (8), (4), (6) and (7). No cooking or keeping quality tests were made with this lot.

In all 258 were selected from this planting. The percentatges and numbers from each are given.

Parent.	Number planted for first cropping.	Number selected from first cropping.	Approximate percentage selected.
Six Weeks	52	18	36
Trinidadian	297	65	22
Red Nut	512	128	25
St. Joseph Water Hole ..	7	2	29
Caroline Lee	3	0	0
White Gilkes	31	3	10
Orange Hill	36	8	22
White Nut	38	5	13
White Sealy	143	28	13

These were planted (1) at Codrington in July and lifted in October, 1929, giving a growing period of fourteen weeks and (2) at Applewhaites for a "long" crop selection. Each seedling occupied at both places a plot of sixteen cane holes (one hill per hole). Check plots of Six Weeks, Trinidadian and Red Nut were planted throughout the experimental area.

The following notes were made at Codrington for each seedling at lifting.

I. Haulm.

(a) Weight
(b) Habit
(c) Leaf shape
(d) Leaf size
(e) Stem colour, and
(f) Stem thickness.

II. Potatoes.

(a) Mode of bearing
(b) Depth of bearing
(c) Number
(d) Weight
(e) Percentage scarabee infection
(f) Colour of flesh
(g) Nature of wood in flesh
(h) Shape
(k) Skin smoothness, and
(m) Skin thickness.

(1) The "catch" crop seedlings were lifted in October. Sixty seedlings which gave the best all round performance in the field were selected. The remaining 198 were eliminated. The sixty were put up in crates for storage. A cooking test was made after twelve days and as a result thirty were eliminated as being of inferior cooking quality.

The remaining thirty were kept in storage and cooked after eight weeks. Everyone was sound and tasted well. This result is astonishing and might argue that sweet potatoes (if selected for soundness at lifting) may, under certain conditions be stored for this time at least.

Notes were taken on sprouting, drying and rotting in storage.

Another cooking test was carried out after sixteen weeks storage. The

majority had tended to dry out. Some however withstood this. In all twenty were fit for cooking and of this number four had good eating quality.

Thirty seedlings were planted out under irrigation at Codrington to give slips for a "catch" crop trial against the standard commercial types in the rainy season of 1930.

(2) The "long" crop seedling trial comprised the same 258 seedlings as the "catch" crop. About three weeks after planting the slips were completely defoliated by caterpillar attack and started to die off. About 160 plants were saved and these are being retained until October of this year for a "long" crop seedling trial and selection.

SECTION III.—COTTON.

INTRODUCTION.

In the Annual Report of this Department for 1928-29 it was stated that a possible means of avoiding pink bollworm attack was (a) by growing cotton "at such a time as the bollworm increase is not favoured by environmental conditions or (b) for such a period as the bollworm cannot cause great harm before the complete picking of the cotton." A variety trial was carried out that year at Blackmans plantation where sowings were made at 5′ spacings on 11th September, 1928. It was seen that there was no appearance of pink bollworm and one variety gave a computed yield of 847 lb. per acre.

Two trials were laid down in areas in St. John's parish considered to be free from pink bollworm. It was hoped to obtain, for the conditions of the experiment, ideas on the influence of (1) variety, (2) spacing and (3) time of planting on (a) yield of seed cotton per unit area (b) time of yield and (c) lint characters.

The trials were carried out at Malvern and Blackmans, the former section being planted early—July 1929—and the latter very late—October, 1929. Owing to severe caterpillar attack, the very late planting and the prevalence of high winds in the experimental field, the Blackmans trial was a failure—an approximate yield of only 300 pounds seed cotton being obtained. The obvious conclusion from this trial is that low yields may be expected under such conditions.

At Malvern plantation the trial was carried out to determine the influence of (1) variety, and (2) spacing on (a) yield of seed cotton per unit area (b) time of yield and (c) lint characters.

There were four varieties tried, viz., Tait's Sea Island, Barbados Sea Island S(27)6, Montserrat H.23-2-13 and Meade (Long Staple American Upland).

Single and double spacings were employed. Thus the first three Sea Island varieties were planted in the single spacing in rows 5′ apart and the plants 20″ in the rows, and in the double spacing in two rows 2′ apart and two 3′ apart and the plants 20″ in the rows. The Meade plants were spaced 15″ apart in rows which in the single spacing were 5′ apart and in the double spacing in rows two at 2′ apart and two at 3′ apart.

In the experimental field there were six blocks (replications) and in each block each variety occurred in two plots, one each to each spacing distance. Thus in any block there were eight plots (four varieties each at two spacings). Each plot was 6 x 5 cane holes —1/58 acre.

Sowings were made on 12th July, 1929. There was good growth throughout the growing period with a pronounced tendency to produce vegetative branches (monopodia). Angular Leaf Spot and Black Arm diseases were prevalent and the Bacterial Boll Rot of the same causative organism caused considerable loss. The latter disease greatly diminished the possible yield and caused the appearance of a high percentage of dirty cotton. Scale insects became common near the end of crop.

Picking commenced on the 27th November, 1929. The total yields and the time of such are given in Table I.

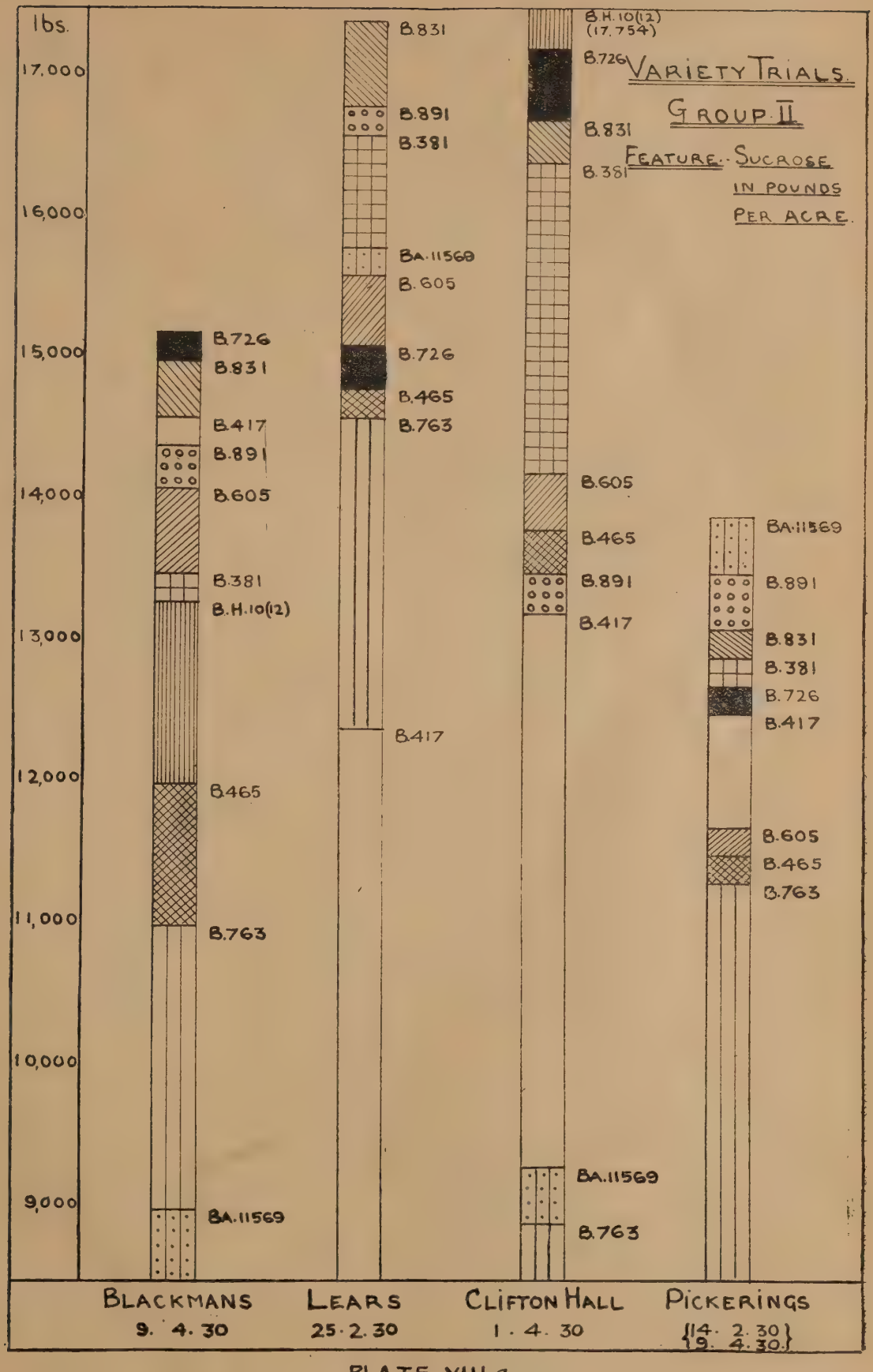
lbs.
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
VARIETY TRIALS.
GROUP II
FEATURE:- SUCROSE IN POUNDS PER ACRE.
B.726
B.831
B.417
B.891
B.605
B.381
B.H.10(12)
B.465
B.763
BA.11569
B.831
B.891
B.381
BA.11569
B.605
B.726
B.465
B.763
B.417
B.H.10(12) (17.754)
B.726
B.831
B.381
B.605
B.465
B.891
B.417
BA.11569
B.763
BA.11569
B.891
B.831
B.381
B.726
B.417
B.605
B.465
B.763
BLACKMANS 9. 4. 30
LEARS 25. 2. 30
CLIFTON HALL 1. 4. 30
PICKERINGS {14. 2. 30 {9. 4. 30}

PLATE VIII a

TABLE I.

COTTON.—VARIETY TRIAL AND SPACING EXPERIMENT AT MALVERN, 1929–30. EACH FIGURE IS THE MEAN YIELD OF SEED COTTON IN POUNDS FOR SIX PLOTS, A TOTAL AREA OF $\frac{1}{97}$ ACRE.

VARIETY	SPACING	DATE AND YIELD IN POUNDS.															
		DAYS.															
		27.11.29 138	12.12.29 153	18.12.29 159	28.12.29 169	5.1. 30 177	16.1. 30 188	21.1. 30 196	30.1. 30 202	7.2. 30 210	12.2. 30 215	20.2. 30 223	27.2. 30 230	6.3. 30 237	13.3. 30 244	Total mean yield per plot pounds.	Computed yield per acre-pounds.
Tait's Sea Island	Single			0.26	0.63	1.53	3.86	2.28	2.10	0.53	1.66	1.00	0.79	0.80	0.08	15.52	901.7
	Double			1.57	0.82	1.59	1.57	3.10	1.85	0.77	0.65	1.19	0.57	0.08	0.09	17.16	997.0
Barbados Sea Island S (27) 6	Single			0.21	0.39	1.16	2.52	2.31	1.57	1.05	1.30	1.33	0.69	0.31	0.18	13.02	756.5
	Double			0.31	1.25	1.11	1.93	2.45	1.72	1.57	1.13	0.89	0.49	0.21	0.11	16.83	977.8
Montserrat Sea Island ...	Single			0.15	0.30	1.09	2.69	2.51	1.39	0.29	1.04	0.83	0.10	0.16	0.08	10.96	636.8
	Double			0.87	0.29	1.26	3.10	2.93	1.59	0.69	0.25	0.76	0.52	0.09	0.05	12.40	720.4
Meade	Single	0.26	2.39	2.30	1.88	1.52	4.33	1.79	0.70	0.16	0.29	—	0.07	—	—	15.69	911.6
	Double	1.38	3.76	2.38	1.42	1.36	3.77	1.46	0.69	0.20	0.20	0.06	—	—	—	16.68	969.1

The following table shows the mean plot yields in pounds of seed cotton for all varieties at both spacings and for the two spacings for all varieties:—

Variety.	Spacing.		Mean plot yield for variety.
	Single.	Double.	
Tait's Sea Island ..	15.52	17.16	16.18
Meade	15.69	16.68	16.34
Barbados S(27)6 ..	13.02	16.83	14.93
Montserrat	10.96	12.40	11.68
Mean of varieties ..	13.80	15.77	

An analysis of variance shows that there are slight signinficant effects of varieties and spacings tested on yield.

A significant difference between the mean plot yields of varieties at both spacings is ± 2.54 pounds seed cotton.

There is not in this experiment a differential response in yield by the varieties to the different spacings.

The comparative effect on yield of seed cotton of the two spacings was estimated by comparing the yield of each and every variety at its two spacing distances in each and all six blocks. This gave in all twenty-four comparable pairs. The difference in yield in pounds of seed cotton in favour of the double spaced plots over the single spaced plots was + 1.33 ± 0.951 (t=1.401; p=c. 0.2). This difference cannot be considered a significant one.

Samples of lint of each variety were obtained and sent to the Imperial Institute for report, which is as follows:—

Sample .. .. A.
Variety of cotton .. Sea Island Barbados S (27) 6. Early Planting.
Description .. Clean, fine, silky, lustrous, cream-coloured cotton, generally free from neps. A small quantity of short broken fibre was present, together with a few specks of green seed-fuzz.
Strength .. .. Very good on the whole, but irregular, some soft, weak fibre being present.
Length of fibres .. From 1.1 to 2.4 in.; mostly from 1.8 to 2.2 in., with an average of 1.92 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean and bright, very fine, but rather wasty, and was valued at 27d. per lb., when "fine" West Indian Sea Island cotton was nominally quoted at 26.5d. per lb.

Sample .. .. B.
Variety of cotton .. Tait's Sea Island (Barbados) Early Planting.
Description .. Clean, fine, silky, lustrous, cream-coloured cotton, almost free from neps. A small amount of short broken fibre was present, together with a few specks of green seed-fuzz.
Strength .. .. Very good on the whole, but irregular, some soft, weak fibre being present.
Length of fibres .. From 0.9 to 2.3 in.; mostly from 1.7 to 2.1 in., with an average of 1.75 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean, bright, fine and of good length, and was valued at 27d. per lb., when "fine" West Indian Sea Island was nominally quoted at 26.5 per lb.

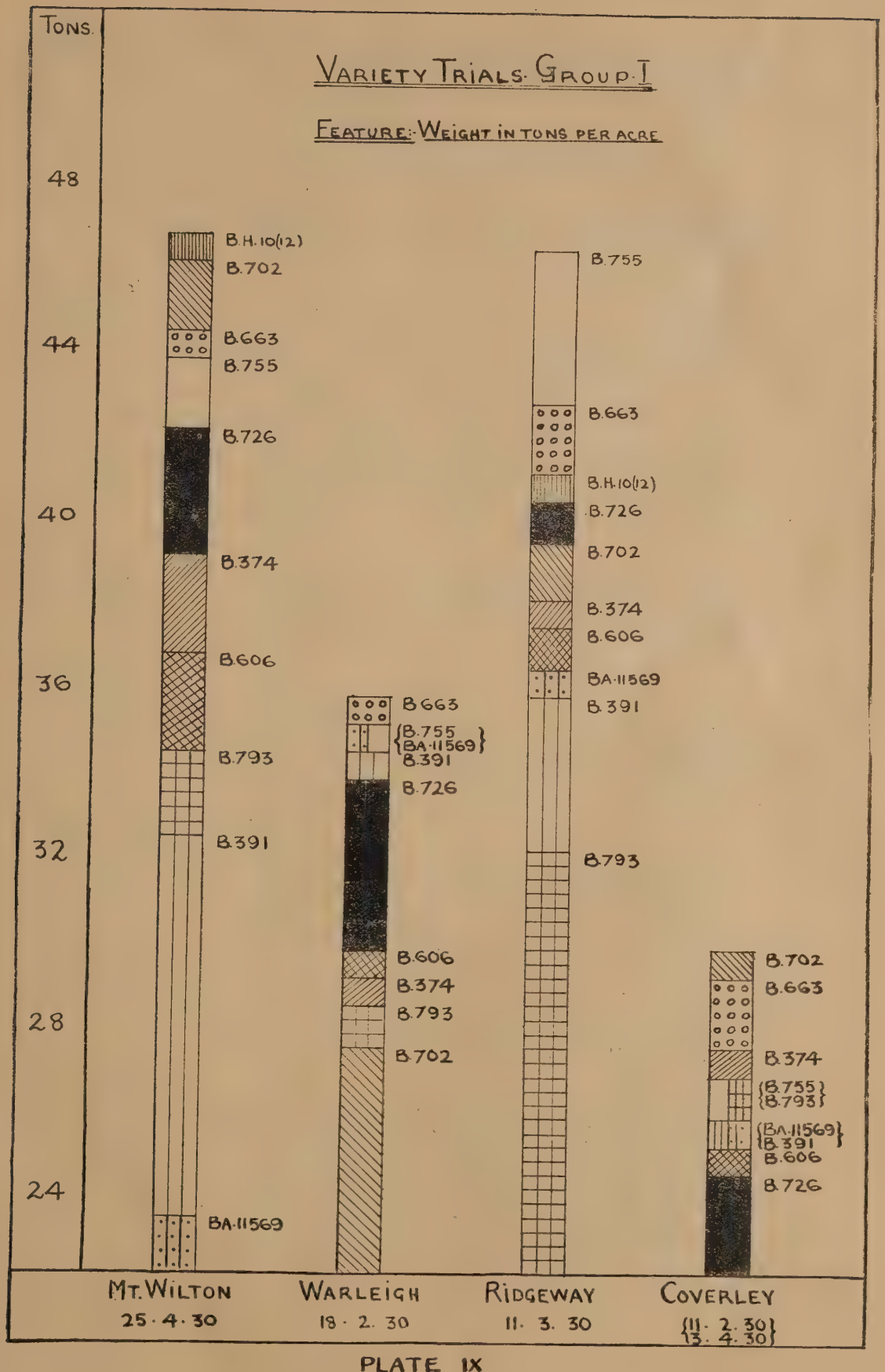
TONS.
VARIETY TRIALS. GROUP I.
FEATURE:- WEIGHT IN TONS PER ACRE
48
44
40
36
32
28
24
B.H.10(12)
B.702
B.663
B.755
B.726
B.374
B.606
B.793
B.391
BA.11569
B.663
{B.755 BA.11569}
B.391
B.726
B.606
B.374
B.793
B.702
B.755
B.663
B.H.10(12)
B.726
B.702
B.374
B.606
BA.11569
B.391
B.793
B.702
B.663
B.374
{B.755 B.793}
{BA.11569 B.391}
B.606
B.726
MT. WILTON
25 · 4 · 30
WARLEIGH
18 · 2. 30
RIDGEWAY
11. 3. 30
COVERLEY
{11 · 2. 30 13 · 4. 30}

PLATE IX

Sample .. .. C.
Variety of cotton .. Montserrat H.23-2-13. Early Planting.
Description .. Clean, fine, lustrous, cream-coloured cotton, very slightly stained in places. The sample was almost free from short and broken fibre.
Strength .. .. Mostly good, but a little uneven.
Length of fibres .. Irregular, from 0.8 to 2.4 in.; mostly from 1.6 to 2.1 in., with an average of 1.73 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean, bright and strong but wanting in length, and was valued at 25.5d. per lb., when "fine" West Indian Sea Island cotton was nominally quoted at 26.5d. per lb.

Sample .. .. D.
Variety of cotton .. Meade (American Long Staple Upland) Early Planting.
Description .. Clean, soft, silky and lustrous, pale cream-coloured cotton, almost free from stain and neps. A small amount of broken fibre was present.
Strength .. .. Fairly good, but weak in parts.
Length of fibres .. From 0.9 to 2.1 in.; mostly from 1.4 in. to 1.8 in., with an average of 1.57 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean and bright but not very strong and was valued at 12.00d. per lb., with "good fair" Egyptian Sakellaridis at 11.95d. per lb.

Sample .. .. E.
Variety of cotton .. Barbados Sea Island Tait's Late Planting.
Description .. Clean, fine, lustrous, cream-coloured cotton, almost free from stain. A small amount of short fibre and neppy matter was present.
Strength .. .. Good.
Length of fibres .. From 1.0 to 2.3 in.; mostly from 1.6 to 2.0 in., with an average of 1.77 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean, bright, fine and moderately strong, and was valued at 25d. per lb. when "fine" West Indian Sea Island cotton was nominally quoted at 26.5d. per lb.

Sample .. .. F.
Variety of cotton .. Meade—American Long Staple Upland Late Planting.
Description .. Clean, soft, silky, lustrous, very pale cream-coloured cotton, slightly stained in places. A small amount of immature fibre was present.
Strength .. .. Fairly good, but a little uneven.
Length of fibres .. From 1.0 to 2.1 in.; mostly from 1.5 to 1.8 in., with an average of 1.60 in.
Commercial valuation The cotton was regarded by brokers in Liverpool as clean and bright and was valued at 11.50d. per lb. with "good fair" Egyptian Sakellaridis at 11.95d. per lb.

General Remarks .. The three Sea Island cottons are of attractive appearance, being of good colour and very clean and lustrous. They are generally of good length and strength, but a little short and soft, weak fibre is present in each case.

The Meade cottons are also very clean and bright but here again the staple is a little uneven. These cottons are of very promising quality and, if they furnish better yields than the Sea Island, they may perhaps prove more profitable to grow.

The results of this experiment lead to several general conclusions.

The varieties did not differ much in yielding capacity. Montserrat was significantly lower in yielding capacity than the other varieties. Moreover, it did not justify its claim as an early maturing Sea Island cotton, being in this respect no earlier than the two Barbados Sea Island strains. From the foregoing report it is seen that its lint is shorter than that of the Barbados cotton, and is quoted at a lower price per pound than the latter.

Meade yielded well and earlier than the Sea Island cottons (see page 50). Its staple however is comparatively short and is offered only between one-half and one-third the price of the Sea Island cottons. It is not considered that this variety can hope to replace Sea Island cotton in Barbados.

Again, as with last year's cotton variety trial, the Tait's strain of Barbados Sea Island has out-yielded the Barbados S (27) 6 strains.

Since it (Tait's) is quoted at the same price per pound as the latter it is considered that this at present is the best all round strain for growing in Barbados.

Although the double spacing did not significantly give from its plots higher yields than the single spacing there was a tendency for double spaced plots to yield higher. It is felt that, on theoretical grounds, such a tendency would be much more pronounced in the later (*i.e.* September) plantings.

It was mentioned earlier on that bacterial boll rot was common in the plants in the Malvern trial. Recommendations have been made by the Imperial Bureau of Mycology to try treating the seed with sulphuric acid, in order to disinfect the seed coats and kill the bacterial parasites on the surface.

SECTION IV. TOBACCO.

Two experiments were made with tobacco, viz. (1) a yield trial, and (2) a curing experiment.

(1) YIELD TRIAL.

The same eight varieties were used as were experimented with previously (see Ann. Report of this Department, 1928-29).

Sowings in boxes were made on 7th June 1929. The seedlings were then pricked out into pots on 17th July, 1929—24th July, 1929. They were then transplanted into the field on 21st August, 1929.

The experimental area was 140′ x 170′. The land was flat forked. Farmyard manure was spread in strips of 170′ long and 3½′ apart—280 lb. to each strip,—a dressing of approximately ten tons per acre. Ridges of soil were made over the manure strips and the plants planted on these at 2′ distances apart.

The "lay-out" employed was the Latin Square and the plot size was 17½′ x 20′ (5 rows at 3½′ by 10 plants at 2′ apart in the rows).

On 11th September 1929 a manurial dressing of the following composition was applied:—

	Dressing (Per Acre.)
Superphosphate	30 lb.
Sodium nitrate	16 „
Cotton seed meal	71 „
Potassium nitrate	16 „

This allowed approximately 0.34 oz. of the mixture per plant.

At crop time the outer rows in each plot were discarded so that yields were obtained from thirty plants from each plot. The leaves were picked at two times, viz 22nd November 1929 and 5th December 1929.

At these dates the variety White Burley was a little beyond its stage of growth for picking.

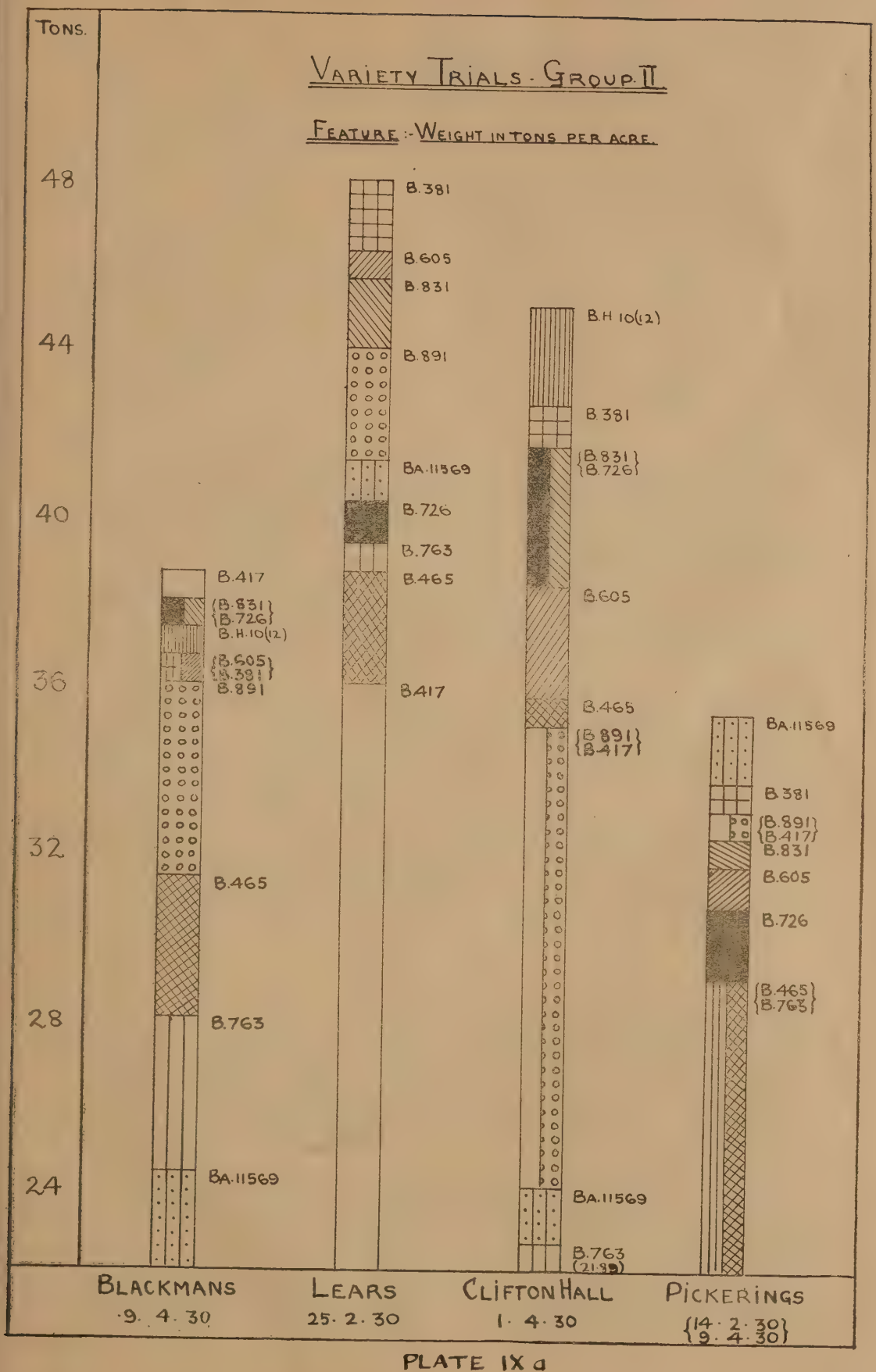
TONS.
VARIETY TRIALS - GROUP II
FEATURE :- WEIGHT IN TONS PER ACRE.
48
44
40
36
32
28
24
B.417
{B.831} {B.726}
B.H.10(12)
{B.605} {B.381}
B.891
B.465
B.763
BA.11569
B.381
B.605
B.831
B.891
BA.11569
B.726
B.763
B.465
B.417
B.H 10(12)
B.381
{B.831} {B.726}
B.605
B.465
{B.891} {B.417}
BA.11569
B.763 (21·8·29)
BA.11569
B.381
{B.891} {B.417}
B.831
B.605
B.726
{B.465} {B.763}
BLACKMANS
·9. 4. 30
LEARS
25. 2. 30
CLIFTON HALL
1. 4. 30
PICKERINGS
{14. 2. 30} {9. 4. 30}

PLATE IX a

TABLE I.

Tobacco—Variety Yield Trial at Codrington, 1929.

Variety.	Mean plot yield in pounds of eight plots.	Calculated yield in pounds per acre.
Hickory Prior	40.0	8320
Maryland	39.9	8294
Tennessee Red	38.9	8086
Kentucky One Sucker	38.5	8008
Gold Leaf	36.5	7592
Yellow Mammoth	33.1	6890
White Burley	31.5	6552
Warne	30.3	6292

An analysis of yield variance shows that there is a slight significant effect of variety on mean plot yield variability. This however is not sufficiently significant to conclude that there is any considerable difference between the varieties in their yielding capacity. A difference between variety mean yields of green leaf per plot of ± 7.56 pounds may be regarded as significant.

From two years experiments (c.f. yield experiment in last year's Report) one can safely conclude that the variety Warne is an inferior yielder in Barbados and may be eliminated from recommendations.

Hickory Prior in both trials has given highest yields, and when it is considered that this variety is highly satisfactory for flue-curing, giving a light coloured leaf in Barbados, it is safe to recommend it as the best all round variety for this purpose.

White Burley came low in the merit list of yield for this year's experiment. This may, however, be accounted for by its being picked at a time when it had passed its optimum period for picking. In the previous trial it was second in the merit list of yield and was then not significantly lower in yield than Hickory Prior. It is recommended as the variety to be grown for producing air cured light coloured tobacco.

Kentucky-One-Sucker is not recommended on account of its possessing very coarse-textured leaves. Tennessee Red would be suitable for production of a dark leaf tobacco for pipe smoking.

The others are not considered especially suited for any category.

(See Report from Imperial Institute on Tobacco samples from Barbados, pages 54—57.

(2) CURING EXPERIMENT.

A controlled air curing experiment was carried out with White Burley, in which it was desired to find out (1) what is the stage in leaf ripeness most suited for picking to give an easy and satisfactory air cure and (2) how the ultimate colour of the leaf can be effected by a partial control of air temperatures and humidities in the air-curing barn.

Sixty White Burley plants were grown on the same system (land preparation, cultivation and manuring, etc.) as was adopted with the variety yield trial experiment.

Leaves were picked from these plants at three stages of maturity. The stage of maturity was decided on by noting (a) colour and (b) position on the plants. Thus after about 3½ months growth the lower leaves in most plants were a lime green (i.e. a colour approaching the colour of sour-grass pasture lands), the middle leaves were a deeper green, while the top leaves were a cress green—the green shades deepened from bottom to top. These colour categories are respectively referred to as A, B, and C. The leaves were placed according to their colour into one of these categories. The leaves in A and B were approxi-

mately 1" longer and .75" broader than in C. Their respective green leaf weights were 26.56 grms., 23.24 grms., and 19.20 grms. On drying they lost respectively 83.81%, 82.87%, and 80.68% moisture. (These figures are obtained from twenty sample leaves from each category).

For the curing experiment, sixty leaves from each category were selected at random from the total pickings and tied into hands of three leaves each. Now, hands of all samples of all three categories were distributed at random on hanging in the barn.

In the barn observations were made on colour changes every morning between 8 a.m. and 9 a.m. until drying was complete. The colours were determined by matching each and every leaf of all three categories with colour samples in Ridgways "Colour Standards and Colour Nomenclature."

Details for leaf colour changes cannot be given here.

The barn possessed top and bottom ventilation and by means of this and heating from the clear flame of burning charcoal in coal pots an attempt was made to control air temperatures and humidities.

Records of the latter phenomena were continuously made on a thermograph and a hygrograph.

The leaves on picking were hung in the barn on the 24th September. Coal pots were put in immediately and all ventilators closed until the 28th September. All ventilators (i.e. top and bottom) were then opened during the day (outside conditions dry and sunny), but only top ones at night. On the 12th October the coal pots were re-introduced and kept going until the 14th October, at which date the midribs were quite dry. The leaves were then taken down and graded into categories (A, B, or C).

In all cases, under the conditions in the barn, if moisture was left too long in the leaves there was a pronounced tendency to produce cinnamon brown coloured leaves. If, on the other hand, all moisture was driven out too rapidly the leaves dried out green. This latter colour is useless for marketing.

There was, for all colour categories (A, B and C) a change through yellows, yellow browns to brown (if drying out was not too rapid). Leaves under category B., however, approached nearest to, but did not attain, the desired lemon yellow, Barium yellow was the nearest approach. This colour was attained by some leaves in categories A and C but to a lesser extent than in B. The leaves under category A tended to dry out a pale straw colour and lacked body. A considerable proportion of the leaves in category C retained a greater or less amount of green. It seemed that moisture could not be retained long enough in these leaves to admit of full change to the yellow colours. These leaves are apparently picked too early for air curing.

The recommendations for air curing arising out of the experiment are these. Leaves of a uniform colour (that is to say leaves of a uniform stage of maturity) should be picked. The best colour appears to be green where only a slight tinge of yellow-green is appearing. This naturally appears first in the lower or older leaves in any crop and spreads gradually into the younger leaves in any one plant. Thus the necessity for several pickings and curings is apparent, since all leaves in the crop do not mature at the same time.

Now such coloured leaves should be hung in the barn and the application of heat, where possible, hastens the rate of colour change. Too quick drying out gives a green dry leaf. At first, therefore, ventilation should only be for a period—say one hour during a dry day—in order to drive off any surface moisture (this avoids "pole sweat"). When the leaves commence to yellow drying should be hastened by adequate ventilations (circulation of air) and high temperatures in the barn. This is in order to have leaf moisure eliminated before the change in colour gets to brown and black.

It should be possible with charcoal fires to get a temperature from 90°–100° Fahrenheit. Should the leaves tend to dry out too quickly moist sacking may be laid on the barn floor.

(3) REPORT ON TOBACCO SAMPLES FROM IMPERIAL INSTITUTE.

Four samples of cured tobacco leaves were forwarded to the Imperial Institute from Barbados, viz:

(1) A sample of air cured White Burley from leaves in category B in the above experiment.

(2) A sample of flue-cured Tennessee Red from a local grower.

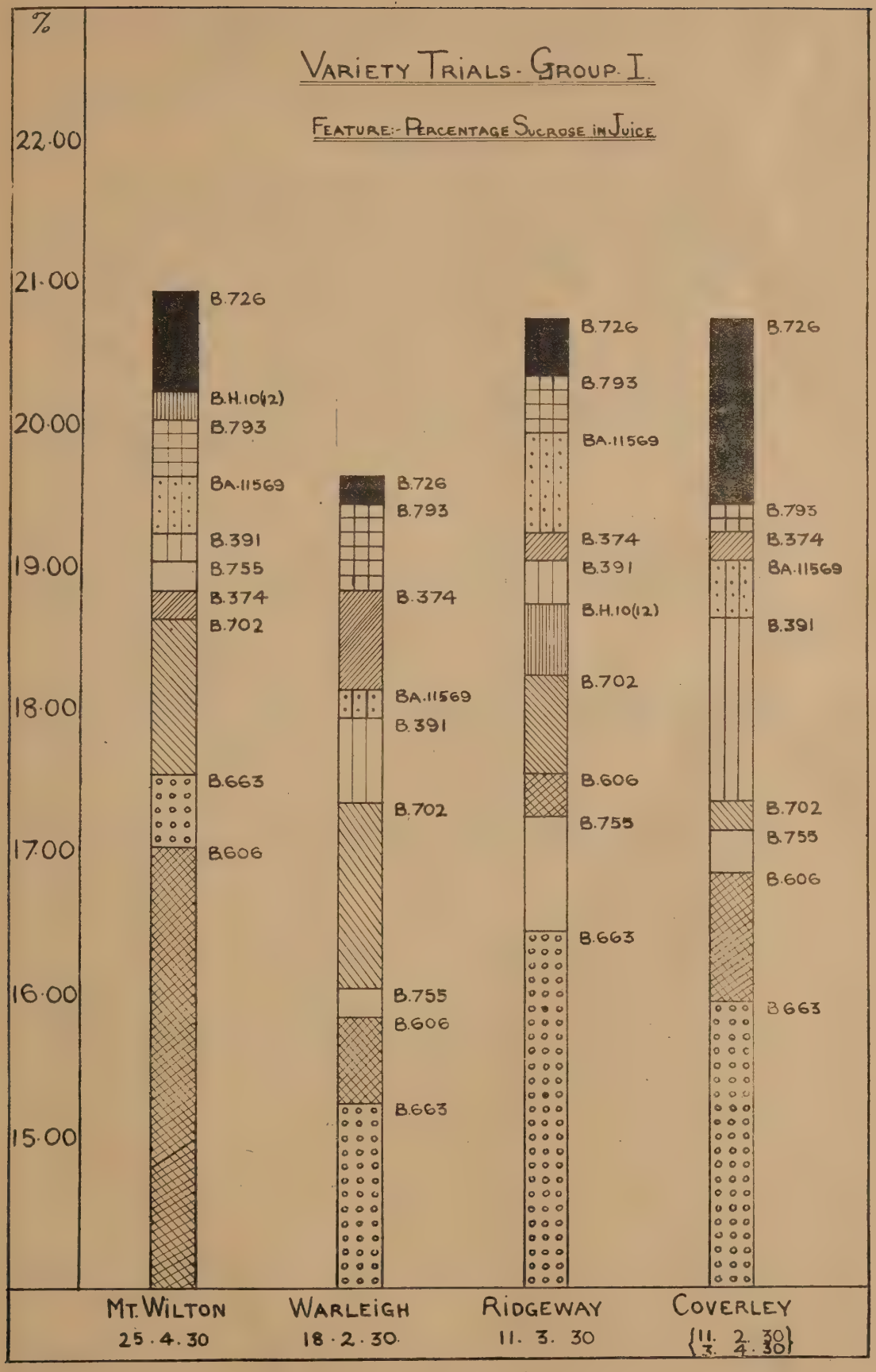
%
VARIETY TRIALS - GROUP I.
FEATURE:- PERCENTAGE SUCROSE IN JUICE
22·00
21·00
20·00
19·00
18·00
17·00
16·00
15·00
B.726
B.H.10(12)
B.793
BA.11569
B.391
B.755
B.374
B.702
B.663
B.606
B.726
B.793
B.374
BA.11569
B.391
B.702
B.755
B.606
B.663
B.726
B.793
BA.11569
B.374
B.391
B.H.10(12)
B.702
B.606
B.755
B.663
B.726
B.793
B.374
BA.11569
B.391
B.702
B.755
B.606
B.663
MT. WILTON
25 · 4 · 30
WARLEIGH
18 · 2 · 30
RIDGEWAY
11. 3. 30
COVERLEY
{11. 2. 30 / 3. 4. 30}

PLATE X

(3) A sample of bright yellow flue-cured Hickory Prior from a local grower.

(4) A sample of dark brown flue-cured Hickory Prior, from the same grower as (3) and the following report has been received:—

DESCRIPTION.

No. 1. White Burley (Air-cured). Weight 1 lb. 2 oz.

Leaves varying in size from 13 x 5 inches to 24 x 10½ inches, and thus on the whole small for White Burley tobacco. The colour was mainly a light warm brown, but some leaves were greenish. The substance was fair, and the texture fairly fine but inclined to be weak. The midribs were small, and the veins small but inclined to be wiry and whitish.

No. 2. Tennessee Red (Flue-cured). Weight 6 lb. 8 oz.

Leaves varying in size from 15 x 7½ inches to 21 x 12 inches, mostly of a light mottled orange colour and badly spotted. The leaf was of fair substance, but brittle and lacking in strength; the midribs and veins were small. The appearance of the sample was very poor.

No. 3. Hickory Pryor. Weight 3 lb. 6 oz.

Leaves varying in size from 13 x 4 inches to 22 x 8 inches. The colour varied from yellow to a mottled orange; the leaves were badly spotted and some showed greenness. The leaf was of fair substance, but lacking in strength; the midribs and veins were fair. The sample was of poor appearance.

No. 4. Hickory Pryor. Weight 3 lb.

Leaves varying in size from 15½ x 6½ inches to 27 x 12 inches. The colour was reddish-brown, but the leaves showed pronounced greenness and were badly spotted. On the whole they were rather weak and brittle: the midribs and veins were fair. The sample was of very poor appearance.

RESULTS OF EXAMINATION.

(1) The samples (lamina only) were chemically examined with the following results, which are expressed on leaf containing 14 per cent of moisture:-

	No. 1. per cent.	No. 2. per cent.	No. 3. per cent.	No. 4. per cent.
Moisture	14.0	14.0	14.0	14.0
Nicotine	2.51	1.73	2.32	2.28
Nitrogen	3.32	1.28	2.42	2.54
Ash	19.9	13.7	17.3	18.8

The composition of the ash of Nos. 1, 2 and 3 was determined with the results shown in the following table:—

		Ash as prepared.			Calculated on CO_2 free Ash.		
		Sample number.			Sample number		
		1	2	3	1	2	3
		%	%	%	%	%	%
Lime	CaO	37.61	40.11	32.92	47.74	54.87	43.20
Magnesia	MgO	3.68	3.40	2.50	4.67	4.65	3.28
Potash	K_2O	14.67	12.61	22.63	18.62	17.25	29.70
Soda	Na_2O	1.33	2.28	1.10	1.69	3.12	1.44
Sulphates, expressed as sulphuric anhydride	SO_3	3.34	4.08	4.02	4.24	5.58	5.27
Chlorides, expressed as chlorine	Cl	13.27	4.96	5.16	16.84	6.79	6.77
Carbonates, expressed as carbon dioxide ...	CO_2	21.22	26.90	23.80	...	...	...

(2) Smoking trials with the four samples gave the following results:

No. 1. The leaf had good burning properties and left a white to grey ash. It had a fairly good flavour.

No. 2. The leaf had good burning properties and left a white to grey ash. The flavour was fairly mild and free from objectionable features.

No. 3. The leaf had good burning properties and left a white to grey ash. It had a fairly mild, sweetish flavour, with indications of rawness.

No. 4. The leaf had good burning properties and left a white to grey ash. The flavour was raw and pungent.

The foregoing results show that the samples are of satisfactory composition; No. 2 contains less nicotine and nitrogen than the three other tobaccos. The analyses of the ash of Nos. 1, 2 and 3 show that in each case the percentage of magnesia present is markedly low, whilst the ash of Nos. 1 and 2 contains a high percentage of lime. In all three cases the quantity of potash present is satisfactory, No. 3 being richer in this constituent than the other two samples. The ash of No. 1 contains a rather high percentage of chlorides, but not sufficient to impair the burning properties of the leaf.

COMMERCIAL VALUE.

The samples were submitted to (a) manufacturers, (b) merchants, and (c) brokers, for opinions as to their quality and suitability for sale in this country.

(a) The manufacturers' leaf expert reported as follows:

"When looking through the samples to-day I made the following notes, which I hope may be of some use to the authorities in Barbados.

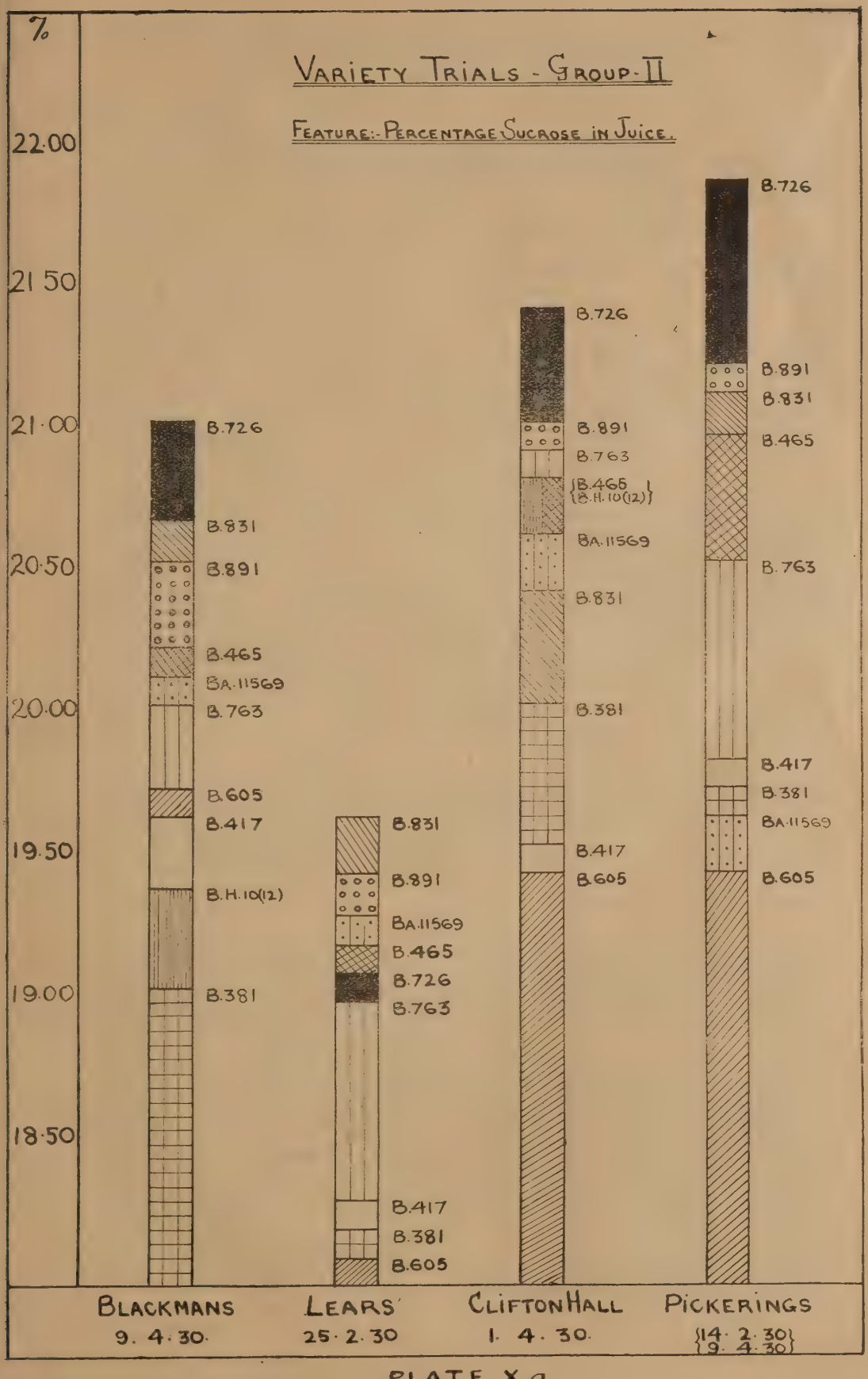
%
VARIETY TRIALS - GROUP-II
FEATURE:- PERCENTAGE SUCROSE IN JUICE.
22.00
21.50
21.00
20.50
20.00
19.50
19.00
18.50
B.726
B.831
B.891
B.465
BA.11569
B.763
B.605
B.417
B.H.10(12)
B.381
B.831
B.891
BA.11569
B.465
B.726
B.763
B.417
B.381
B.605
B.726
B.891
B.763
{B.465 {B.H.10(12)}
BA.11569
B.831
B.381
B.417
B.605
B.726
B.891
B.831
B.465
B.763
B.417
B.381
BA.11569
B.605
BLACKMANS
9. 4. 30.
LEARS'
25. 2. 30
CLIFTON HALL
1. 4. 30.
PICKERINGS
{14. 2. 30}
{9. 4. 30}

PLATE X a

No. 1. Colour. Not rich enough for Burley Tobacco. Too pale and dull.
Flavour. Unobjectionable, but not true Burley type.
Quality. Some of the leaves are too thin and perished to be of commercial value.

No. 2. Colour. Very fair.
Flavour. Unlike that of American flue-cured tobacco.
Quality. The leaves are badly blistered, and show signs of disease, which may perhaps be due to wet weather, or to lack of experience in harvesting and curing. I doubt whether this is the right kind of seed to use for flue-cured tobacco.

No. 3. Colour. Low grade semi-bright colour.
Flavour. Bad. Although not mouldy, this tobacco is definitely in unsound condition.

No. 4. Colour. Mainly dark tobacco, but very mixed.
Flavour. Poor.
Quality. Tobacco is very thin. Some of the leaves are diseased, and on the whole it would be of no interest to this market.

"I cannot honestly say that any of these varieties look very promising, but of the four, I think the flue-cured is least undesirable. Further experiments with other kinds of seed that are particularly suitable for flue-cured tobacco might be worth consideration."

(b) The merchants expressed the following views:—

We have now examined and tested the samples of Barbados tobaccos, and regret to inform you that in our opinion these tobaccos are of no practical use to this market at their present stage. In the first place the tobacco is much too coarse, smokes rank, and has a very unpleasant flavour. Secondly, the leaves are more or less covered with spots, presumably rainspots, which considerably depreciates the value of any tobacco leaf, the effect of these spots being to cause shorts in cutting, and consequent waste. We might say that the combustion is good, samples cut up burning freely and with a good white ash.

(c) The brokers furnished the following report:

No. 1. This is similar to the original White Burley. We think that on this market a price of 10d. to 1s. per lb. would be realised.

No. 2. This tobacco would be suitable for this country except that the leaves are badly spotted. If the tobacco were clean, it should realise a price of 10d. to 11d. per lb.

No. 3. We should think this was grown from Hickory Pryor seed. Here again the tobacco is spotted, but if it could be obtained clean, the leaf should suit this market at around 9d. to 10d. per lb.

No. 4. This tobacco is not suitable for this market being much too thin and badly mixed, and the majority green.

REMARKS.

The leaves in these four samples were small, and showed greenness, which in No. 4 was very pronounced. They possessed fair substance, but were inclined to be weak. Nos. 2, 3 and 4 were badly spotted and of poor appearance. All the samples burned well; No. 1 had a fairly good flavour, Nos. 2 and 3 were fairly mild, whilst No. 4 was raw and pungent.

Nos. 1, 2 and 3 may be suitable for the local demand in Barbados. The last two could be improved by after-fermentation and maturing, and if better prepared might be used in the United Kingdom for pipe mixture, and possibly for cigarettes. It may be mentioned that Burley leaf (No. 1) is not suitable for cigarettes, and is generally employed in the United Kingdom for pipe mixtures.

The samples are not of very high quality and the trade opinions regarding their market possibilities show some variation. There is little doubt, however, that tobacco represented by the present samples would not be readily saleable in the United Kingdom.

For flue-cured cigarette leaf there are more suitable varieties than Red Tennessee (which is usually fire-cured) and it would be advisable to try, in addition to Hickory Pryor, such varieties as Gold Leaf, Warne, Adcock and White-

stemmed Orinoco. The present types could no doubt be improved by after-fermentation and maturing, but it would be advisable to cure them more efficiently and to prevent the spotting of the leaves.

SECTION V.—EXPERIMENTS WITH ECONOMIC LEGUMES.

Experiments on economic legumes were made to determine their relative values in Barbados as plants for (1) green manure and/or soiling, and/or (2) pea or bean production.

Two experiments were laid down, viz. (1) a green manure trial and (2) a pea and bean experiment.

(1) GREEN MANURE TRIAL.

In this trial eight species were tried, viz., Florida Velvet Bean (*Mucuna utilis* syn., (*Stizolobium deeringianum*), Rattlepod (*Crotalaria usarmoensis*), Cowpea (*Vigna sinensis*), Bengal or Velvet Bean (*Stizolobium pachylobium*), Woolly Pyrol (*Phaseolous mungo*), Creeping Bonavist (*Dolichos lablab*), Soya Bean (*Glycine hispida*) and Horse Bean (*Canavalia ensiformis*).

It was desirable to know for each species its (1) ease of germination (2) yield of haulm in time (3) freedom from pests and (4) manurial value.

Yield in time of these species will be considered. In the "lay-out" employed there were four blocks in each of which the eight species and one control (no green manure plants) were randomised. Each plot was 5 x 5 cane holes and an amount of seeds of each species was sown over an area considered to give for the species when at full vegetative growth (i.e. the optimum turning in period) an adequate cover for the 5 x 5 area. The area covered by several species at full vegetation either exceeded or was less than this area. Such areas were determined, the yields noted, and then, for sake of comparisons, yields were computed for a 5 x 5 cane hole area.

The following sowing methods and distances were employed.

Crotalaria usarmoensis—seeds broadcast lightly over the entire 5 x 5 cane hole plot excluding cane holes in the plot.

Stizolobium pachylobium—seeds planted by hand in rows 2′ apart and seeds 1′ in the rows—a 2½′ spread of vegetation was allowed for.

Vigna sinensis and *Glycine hispida*—seeds hand sown in rows 15″ apart and seeds 9″ apart in rows alowing a 6″ spread to edge of plot. Two seeds were sown at any one place.

Phaseolus mungo—seeds hand sown in centre of cane hole, centres of bank, saddle and square. Eight seeds were sown at any one place.

Dolichlos lablab and Mucuna utilis—seeds sown in rows 2′ apart and 1′ apart in rows—a spread of 2½′ was allowed for.

Canavalia ensiformis—seeds sown in rows 18″ apart and 12″ apart in rows —a spread of 2½′ was allowed for.

Single cane hole widths (5′) surrounded each plot. These were left unsown.

Sowings were made on the 14th August, 1929. On 4th October, however, re-sowings of all except Crotalaria had to be made owing to excessive caterpillar damage.

As each species reached what was considered its optimum vegetative development, it was cut, weighed in the fresh state and turned into furrows made in the straight banks between the cane holes.

The table below gives the yields at cutting and the duration of the growing period for each species.

TABLE I.

GREEN MANURE EXPERIMENT—CODRINGTON 1929.

Yield in pounds of green matter. Each figure for each species is the mean of four plots of 5 x 5 cane holes (approximately 1/70 acre).

Species.	Common name.	Duration of growing period (days).	Yield lb.	Tons per acre approx.
Crotalaria usarmoensis ..	Rattlepod ..	128	399.5	12.50
Stizolobium pachylobium	Bengal or Velvet Bean ..	111	303.8	9.48
Dolichos lablab	Creeping Bonavist ..	111	215.0	6.72
Mucuna utilis	Florida Velvet Bean	97	192.9	6.03
Phaseolus mungo ..	Wooly Pyrol ..	111	148.2	4.63
Canavalia ensiformis ..	Sword Bean ..	96	131.6	4.11
Vigna sinensis	Cowpea	96	103.3	3.22
Glycine hispida	Soya Bean	111	45.0	1.40

Statistical notes.—Analysis of variance revealed a highly significant effect of variety on yield. A difference between variety means of ±36.18lb. may be regarded as significant.

Notes were made on the features of germination and immunity to insect attack. These, together with the above yield in time give a general impression of the relative values of the species for green manuring in Barbados.

REMARKS.

Crotalaria usarmoensis. This is a small seeded species and requires surface soil moisture during germination and establishment. Excessive rains cause washing of the seeds and seedlings in the small stage. Growth is very slow at first, but once fully established the plants grow very quickly and give very high yields. Flowering and seeding is profuse. Leaf caterpillar attack has so far been negligible. This species is high in nitrogen.

The difficulty with this species is (1) risk of non-establishment, and (2) rather long growing period.

Stizolobium pachylobium. This is an easily established species with rapid growth and high yield at cutting. It is only average in nitrogen content. It produces its yield in a comparatively short time. Apart from its liability to attack by caterpillar, it would be an ideal green manure or fodder crop for Barbados conditions.

Dolichos lablab. This yields less than the above, but, from the green manuring point of view resembles it in the other economic aspects.

Mucuna utilis gives a lower yield than the two previous species, but in a shorter time. Caterpillars attack it severely and it does not appear to be so well suited for green manuring purposes as either of the two previously noted species.

Phaseolus mungo. This species is easily established, gives an average yield in an average time and is badly attacked by caterpillar. It is only average in nitrogen content. It is certainly not so good as *Stizolobium* for green manuring purposes.

Canavalia ensiformis. This species is easily established. In the trial, however, its yield was considerably diminished by heavy attacks of a bud and shoot boring larva. It grows moderately quickly. If this pest damage were to be general throughout Barbados, *Canavalia* could not be considered suitable to replace, say, *Stizolobium*.

Vigna sinensis. This species is easily established, grows quickly and yields a comparatively low weight of green matter in a short time. It is comparatively free from caterpillar attack and might be of use as a green manure which is required in a very short time.

Glycine hispida. This strain of soya bean used was found to be quite inadequate for green manuring purposes. Other strains with a more vigorous growth may serve better and introductions are at present being made.

GENERAL. There is, as yet, no satisfactory green manure species. *Stizolobium* and *Dolichos* are the most promising, but these are readily and heavily attacked by caterpillars. The *Crotalaria* is slow in reaching its optimum in yield of vegetation and is difficult to establish.

For the present and pending further investigations *Stizolobium* is recommended for green manuring purposes or for cutting green and feeding to stock.

After cutting and weighing these species used in the green manure experiment, the fresh green vines were turned into furrows made in the straight bank and covered with a thin layer of soil. The entire experimental area, including the vacant canes holes around each variety plot, was planted with setts of B.726 sugar cane.

The stools from the holes surrounding each plot will be discarded at cutting (they serve as border plants to each plot).

The effects of green manuring and the relative merits of each species used on the weight of the B.726 plants planted after turning in the green manure plants will be determined during the 1931 crop season.

PEA AND BEAN EXPERIMENT.

It was desired to know for several economic legume species their relative merits as pea or bean producers. Merit was judged by (1) yield of peas or beans, (2) time of yield and (3) quality of seeds for (a) human or stock consumption (palatability and nutritive value) and/or (b) oil content (amount and value of oil and food value of residual meal).

A preliminary field trial was laid down to obtain information on (1) yield and (2) time of yield.

In all, twelve species were tried. These were sown in four blocks and in each block all twelve were distributed at random. Each variety plot in any one block comprised an area of 4 x 4 cane holes (approximately 1/110 acre) and a cane hole width (5′) was left vacant around each plot. Again, as in the case of the green manure experiment, in any plot only such an area of ground was sown for any species to give an optimum spacing of the mature plants as seed bearers.

Seed supplying was done, where seeds failed to germinate, about three weeks after sowing. It may be said here that germination in all species was excellent and very little supplying was necessary.

The produce (seeds) from each plot was collected at intervals when ripe. Each plot was treated separately. The seeds were collected and weighed and the date of collecting noted. Thus for any species, data was obtained for all its four plots of yield and time of yield.

The results are presented in the following table. Owing to space restriction in this report plot details are not included.

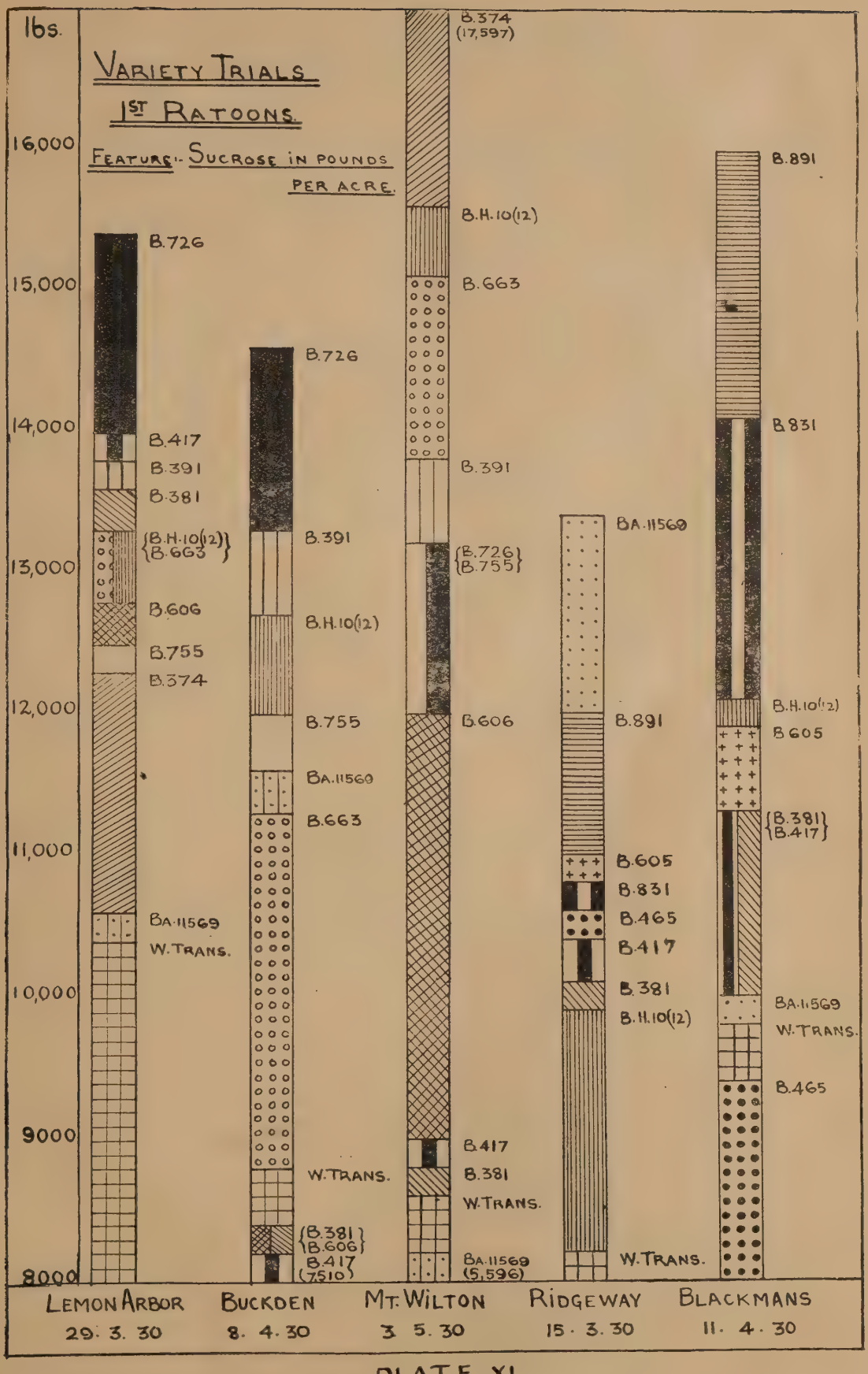
lbs.
VARIETY TRIALS
1ST RATOONS.
FEATURE:- SUCROSE IN POUNDS PER ACRE.
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9000
8000
B.726
B.417
B.391
B.381
{B.H.10(12)} {B.663}
B.606
B.755
B.374
BA.11569
W.TRANS.
B.726
B.391
B.H.10(12)
B.755
BA.11560
B.663
W.TRANS.
{B.381} {B.606}
B.417 (7510)
B.374 (17,597)
B.H.10(12)
B.663
B.391
{B.726} {B.755}
B.606
B.417
B.381
W.TRANS.
BA.11569 (5,596)
BA.11569
B.891
B.831
B.605
B.465
B.417
B.381
B.H.10(12)
W.TRANS.
B.891
B.831
B.H.10(12)
B.605
{B.381} {B.417}
BA.11569
W.TRANS.
B.465
LEMON ARBOR 29. 3. 30
BUCKDEN 8. 4. 30
MT. WILTON 3 5. 30
RIDGEWAY 15. 3. 30
BLACKMANS 11. 4. 30

PLATE XI

TABLE II.

Pea and Bean Experiment—Codrington, 1929–30—Planted 26.9.29.

Yield of Peas or Beans—Each figure for any species is the mean yield in lb. per plot.

Species.	*Common Name*	Picking Date. Sowing Distances		December 1929.		January. 1930.		February.		March.		April.		Mean of four plots for all picking dates.	Computed yield per acre in pounds.
		Bet. Rows	In Rows.	1-15	16-31	1-15	16-31	1-15	16-28	1-15	16-31	1-15	16-30		
Canavalia ensiformis ...	Sword Bean	18″	12″						3 74	4.05	5.12	4.26	2 84	20.01	2180.0
Stizolobium pachylobium	Velvet or Bengal Bean	24°	12″							15.72				15.72	1713.5
„ aterrimum	do. do.	24″	12″						15.09					15.09	1644.8
Six Weeks, Bush Bean ..	Six Weeks or Bush Bean	18″	12″			1.13	2.18		2 50		1.53	3 72	0.53	11.59	1270.9
Dolichos lablab (upright)	Upright Bonavist ...	18″	12″			0.50	1.81		2.53	1.09	1.11	1.47		8.51	926.5
Arachis hypogea ...	Groundnut	30″	30″									7.73		7 73	842.6
Mucuna utilis	Florida Velvet Bean ..	24″	12″			6.04			0.60					6.64	706.3
Phaseolus mungo	Woolly Pyrol	30″	30″					5 39	0 93					6.32	688.9
„ lunatus ...	Lima Bean	18″	12″			0.10	0.54		1.17		2.83	0.89	0.58	6 02	658.4
Vigna sinensis	Cow Pea	15″	12″	3.85	1.37									5.22	564.6
Rounceval Pea	Rounceval Pea ...	15″	12″	2.83	0.48									3.31	385.9
Glycine hispida	Soya Bean	15″	9″			1.21	1.12	0.94						3 27	355.3

An analysis of the factors influencing the variability in plot yield shows that the contribution of varieties to this is highly significant. A minimum difference of ± 2.68 pounds of seeds between any two variety means of four plots may be regarded as a significant one.

General Conclusions.—The Ground Nut (*Arachis hypogea*) and Soya Bean (*Glycine hispida*) may be safely used as a human or stock food in the "whole" state. Generally, however, these have their oil extracted. The residues make a highly nutritious cattle meal or plant manure. Soya Bean tried in Barbados so far has failed for two chief reasons—(1) its attack by hares in the young stages, and (2) its poor yield. It is hoped that by the introduction of several strains with wide range in habit the latter may be overcome. At present this species cannot be recommended. The Ground Nut is too slow in bearing and ripening and could not be grown as a "catch crop." With an importation of several varieties and altered spacing methods, it may serve as a valuable crop in thrown-out land. This will be the subject of future experimenting.

The other species tried in this experiment are low in oil-content.

All can serve, either as "whole" seeds or meal, for cattle food, while Six Weeks or Bush Bean, Upright Bonavist (*Dolichos lablab*) Lima Bean (*Phaseolus eunatus*), Cowpea (*Vigna sinensis*) and Rounceval Pea are suitable for human consumption.

For "catch" cropping purposes only Cowpea and Rounceval Pea would serve while the others would have to be sown in thrown-out land. For the latter category as a food for human consumption, upright Bonavist (*Dolichos lablab*) and Six Weeks Bean appear to be best suited, while for stock feed, Sword Bean (*Canavdlia ensiformis*) and the Velvet Bean (*Stizolobium pachylobium* and *S. aterrimum*) are probably best.

SECTION VI. SOYA BEANS.

A preliminary experiment was carried out in three strains of this plant in 1928 and was reported on in the Departmental Report for 1928-29.

From this experiment it was seen that the quality of the beans (size, colour and oil content) was highly satisfactory. No nodules had, however, developed on the plants. The plots were too small to obtain indications of yield from these strains. Cutworm attack in the cotyledon stage was severe and hares seemed to have a peculiar liking for the plants.

In 1929, it was hoped to run a series of experiments with a large selection of strains from the United States of America but these did not arrive.

A field experiment was carried out with the original three varieties experimented on in 1928. These were sown in the dry season and irrigated. Cultures of the Soya Bean nodule organisms were obtained from the States.

The experiment had for its objects determinations of the effects of (1) strain, and (2) inoculation on (a) the yield and time of yield of beans, and (b) the extent of nodule development.

All three strains were sown in the irrigated experimental patch. There were six blocks (replications) and in each block the strains were placed at random. Each strain plot consisted of six rows—the outer rows being treated as guard rows. The four inner were treated as follows:—two were sown with treated (inoculated) seed* and two with untreated (non-inoculated) seed and laid out on Student's system for obtaining comparable pairs.

The spacings were as follows:—

Symbol.	Strain.	Spacing between rows.	Between Plants in the rows.
M	(1) U.S.A. strain	20 inches.	9 inches.
N	(2) Selection from Venezuelan Seed	15 „	4 „
O	(3) Selection from Venezuelan Seed	20 „	9 „

* The seeds for the treated plots were inoculated after the manner recommended recently by workers at Rothamsted. It consisted in soaking the seeds for a quarter of an hour in milk to which had been added an amount of acid calcium phosphate and a loopful of the growth slime of the organism from a pure culture. The seeds were then taken out and dried away from the sun's rays and then sown.

The soil in the experimental block was forked and pulverised and allowed to lie for six weeks. On April 17th, 1929, the land was thoroughly soaked with irrigation water just prior to sowing. Soakings were made on 19th-22nd April, 1929.

In presenting the results it should be pointed out that bacterial nodules were present on the plants in both the inoculated and non-inoculated rows in all varieties and all plots. Since nodules were not present on the Soya Bean plants in their first trial here (1928) it was considered that the strain necessary for Soya Bean infection was not present in our soils. It is assumed that on this experiment the organism spreads in the irrigation water from plants in treated to non-treated rows. This shows, however, the efficacy of this seed inoculation method.

It is obvious that the effects of inoculation could not be determined in this experiment.

The data presented, however, gives an indication of the yields of the varieties under the conditions of the experiment.

TABLE I.

SOYA BEAN.—YIELD AND TIME OF YIELD OF THREE STRAINS. CODRINGTON, 1929.

Each figure is the mean yield of beans per plot.

Strain.	Symbol.	Days.				Total mean yield per plot for all picking dates (ozs.)	Computed yield of beans in lb. per acre.
		86	94 Yield	102 (ozs.)	111		
1. Selection from Venezuelan seed ..	N	17.71	4.33	5.17	...	27.21	822.30
2. U.S.A. strain ..	M	...	...	27.33	8.41	35.74	811.00
3. Selection from Venezuelan seed ..	O	...	...	27.60	7.00	34.60	766.84

Seed samples from each strain were analysed for oil content with the following results:—

Symbol.	Per Cent. Oil.
N	22.46
M	22.84
O	21.82

Further experiments will be made with Soya Bean over a wider range of growth types. At present no definite recommendations can be made, but it is seen that in Barbados in these experiments the oil content compared favourably with that obtained in the United States. The computed yield per acre here, however, is only approximately half of the average yield in the United States. It may be possible to increase this yield through introducing other varieties. The rate of maturity is remarkably short—for N strain, approximately three months.

It is interesting to compare the yield per acre and time of yield with the same features for several species of legumes in the Pea and Bean Experiment.

The Soya Beans in that experiment described earlier in this report were badly eaten by hares and that, no doubt, accounts for their low yield. When protected from hares (as in this experiment) their yield is greatly increased. Moreover, in the latter experiment they outyielded the Rounceval and Cowpea plants in the Pea and Bean Experiment. Soya Beans yield almost in as short a time as the latter.

It is probable that Soya Beans will compete with Rounceval Pea for a seed producing "catch" crop. If the yield features were equal the Soya Bean is a

more valuable plant when its nutritive value and many uses are considered and would certainly replace to advantage the Rounceval Pea.

The results from this crop are encouraging and it will be persevered with.

SECTION VII.—SUNFLOWER.

The sunflower plant has many uses. It yields a high weight of green matter which can be cut and fed in the green state or made into silage. The immature flower heads make a good cattle food, while the stalks and leaves may be used as a soil mulch or turned in to serve as a green manure. The mature seeds on extraction yield a high percentage of edible oil while the residue makes a nutritious cattle food or organic manure. The whole seeds make a good poultry food.

The sunflower has yielded successfully in Rhodesia under comparatively dry conditions, and it was hoped that, on introduction here, it might grow and yield a good crop of seeds in the dry season.

Seed samples of four varieties of Rhodesian sunflower were imported and grown here during the dry season. Two sowings were made:—

A. a sowing of each variety under garden conditions to acclimatise the plants and multiply the seeds of each for large trial sowings later on. To ensure the retention of purity of seed in each variety, each was sown in an isolated spot and the flower heads bagged.

B. a small field trial to test the general and varietal growth response to the dry season conditions.

For the latter trial, a piece of land at Codrington Experiment Station measuring 120′ x 50′ was chosen. The land was forked, broken down, levelled and soaked with irrigation water prior to sowing. Seeds were sown on the 24th February and watered with watering cans after sowing. No more water was applied after this.

The rows were 3′ apart and the seeds were sown at 4″ intervals in the rows and the plants on germination thinned out to 8″ intervals. Germination was little short of 100%.

There were five blocks and in each block the four varieties were distributed at random. Each variety plot consisted of two rows.

Observations were made for each variety on its rates of growth, flower production and flower maturation (i.e., from time of flower bud production until seed maturation).

During maturation of the seeds, sparrows became troublesome and had to be continually chased away.

There was, for all varieties, a good growth and 100% flowering. Varieties differed in their rates and extents of growth, in their times of flowering, and in their sizes of flower heads and the numbers and weights of seeds per flower head. The point of greatest importance, however, was the varietal difference noted in the seed development in varieties. Speaking for all varieties there was only an indifferent filling of the seeds, *i.e.*, embryo or germ development. This did not appear to be due to lack of fertilisation, for all stages in embryo development were noted. It appeared to be due to lack of nutrition and this may be attributed to the lack of soil moisture at the critical stage of seed growth and maturation.

The flower heads, when ripe, were cut when in a dry state, sunned and their seeds picked off. These were dried and analysed for their oil content.

Seed oil analyses for all varieties were made from (a) the imported seed samples and (b) the locally produced seed.

These are appended in Table I.

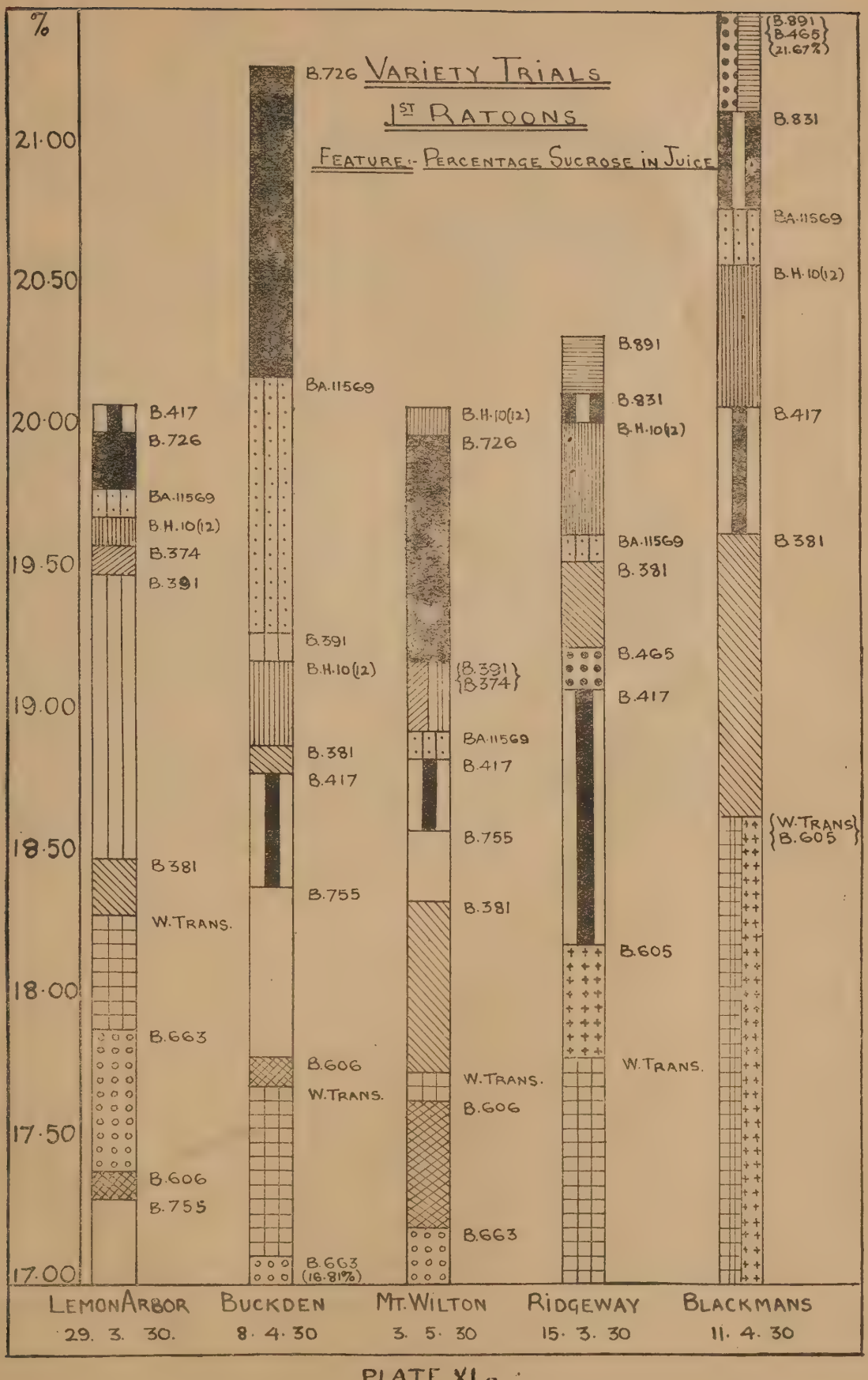
%
21·00
20·50
20·00
19·50
19·00
18·50
18·00
17·50
17·00
B.726 VARIETY TRIALS
1ST RATOONS
FEATURE:- PERCENTAGE SUCROSE IN JUICE
B.417
B.726
BA.11569
B.H.10(12)
B.374
B.391
B.381
W.TRANS.
B.663
B.606
B.755
BA.11569
B.391
B.H.10(12)
B.381
B.417
B.755
B.606
W.TRANS.
B.663 (16.81%)
B.H.10(12)
B.726
{B.391}
{B.374}
BA.11569
B.417
B.755
B.381
W.TRANS.
B.606
B.663
B.891
B.831
B.H.10(12)
BA.11569
B.381
B.465
B.417
B.605
W.TRANS.
{B.891}
{B.465}
(21.67%)
B.831
BA.11569
B.H.10(12)
B.417
B.381
{W.TRANS}
{B.605}
LEMON ARBOR 29. 3. 30.
BUCKDEN 8. 4. 30
MT. WILTON 3. 5. 30
RIDGEWAY 15. 3. 30
BLACKMANS 11. 4. 30

PLATE XI a

TABLE I.

SUNFLOWER—CODRINGTON, 1930.

Oil analyses for imported samples and locally grown seed of four varieties of Rhodesian Sunflower.

Variety.	Samples from imported seed	Oil in 100 parts seed. Samples from locally grown seed	
		Selected sample	Random sample
Rhodesian White No. 7 strain	29.53	22.60	21.30
Rhodesian White No. 5 K strain ..	26.10	15.00	11.07
Rhodesian Small Black	29.07	17.53	12.90
Rhodesian Black No. 30	26.67	16.43	13.20

The low oil content in one hundred parts of seed from samples of locally produced seed was due to the smallness of the embryo (germs). The seed coats were as large as those of the imported samples, but whereas those of the latter were filled by the embryos, those of the locally produced seed were only partially so. In taking samples of the locally grown seed two selections were made in each variety, viz., (a) a selection of the best filled seeds and (b) a random selection. The latter contained seeds as produced by the variety and represented to a greater or less extent the type of seed produced by the variety under local conditions, while the former was a selection from any variety of its best seeds produced locally.

From the results it is seen that the locally produced seed contains appreciably less oil in one hundred parts than the imported seed and that selected seed of the latter contains in each variety a higher oil content than seed from random samples. These features are in all probability due to the poor embryo development in local seed.

Another sowing of all varieties is to be made during the rainy season.

Chapter III.

AGRICULTURAL CHEMISTRY AND GOVERNMENT LABORATORY.

REPORT OF THE AGRICULTURAL CHEMIST.

(S. J. SAINT, B.Sc., A.I.C.)

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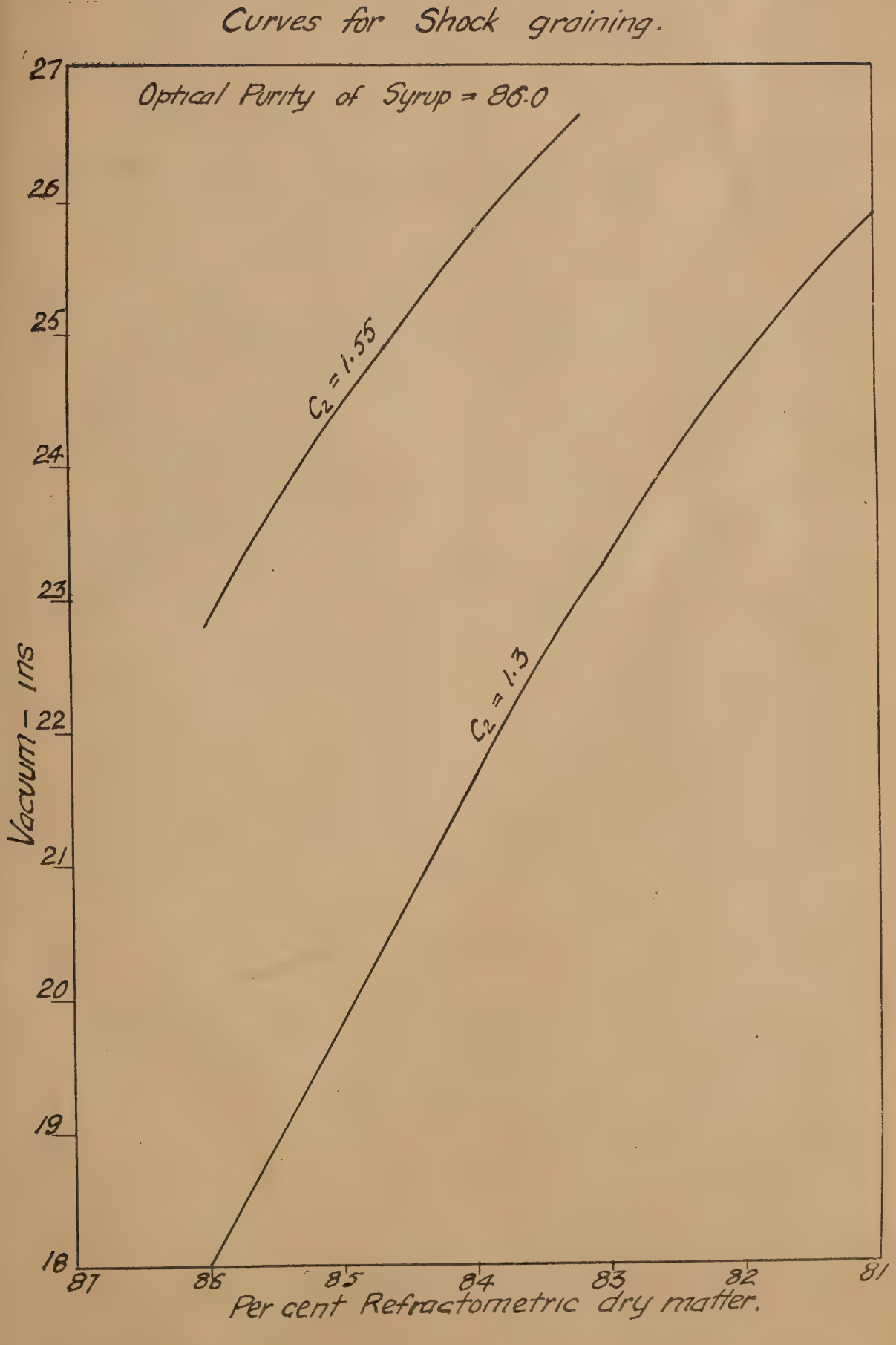
Curves for Shock graining.
Optical Purity of Syrup = 86.0
$C_2 = 1.55$
$C_2 = 1.3$
Vacuum - ins
27
26
25
24
23
22
21
20
19
18
87
86
85
84
83
82
81
Per cent Refractometric dry matter.

FIG 1

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INTRODUCTION.

In addition to the routine analytical work necessarily associated with a Government Laboratory, a continuation has been made of the investigational and advisory work in sugar technology and local soil conditions. As compared with the previous year reported on (1) a considerably greater amount of advisory work has been carried out, with the result that the time available for investigations has been very much limited. During the past crop season, in response to requests, twenty-nine advisory visits were paid to various factories.

The work which has been carried out and which will be dealt with in sections, has been rendered possible only by the loyal co-operation and careful analytical work of the staff. Mr. C. A. Coppin assisted by Mr. H. A. Jones has been responsible for the general analytical work. Mr. G. O. Batson for the analysis of sugars and syrups, Mr. C. St. A. Alleyne for the analysis of juice and megass in connection with the genetical work of the Department and Mr. L. A. Hall for ash analysis of juice and analysis of soils. I wish to record here my appreciation of the excellent work which has been performed by these officers.

SECTION I.—SUGAR TECHNOLOGY.

(A) The Scientific Control of Pan Boiling.

The investigations which were carried out on pan boiling at Carrington Factory during the crop season of 1929 and which were summarised in last year's report, have been published in more detail (2). It was indicated in this paper that further investigations would be necessary to determine whether, in the "shock" method of graining, the number of crystals formed could be regulated by controlling the supersaturations of the syrup. It would be impracticable to carry out such experiments in a factory vacuum pan since such work would upset the factory routine and possibly result in considerable losses of sugar. A small model vacuum pan of 2 ft. diameter was therefore ordered with the permission of the Board of Agriculture. This pan was provided with fittings to take the Zeiss Industrial Refractometer and, on arrival, it was fitted up at Carrington Factory as illustrated in plates XII and XIII. Plate XIII shows the pan after the extra belt which had been added to increase its capacity had been boarded in. The kindness of the management of Carrington Factory in allowing this work to be proceeded with and the ready help given at all times by Mr. Greenidge, the Manager and Mr. Hutchins, the Chemist, are here gratefully acknowledged.

1. *The Determination of Crystal Numbers.*

In the investigation of the effect of supersaturation of sugar syrups on crystal numbers, it was necessary to have some method of accurately determining the number of crystals present at any time. The only practical method which could be found in the literature was that developed by Thieme (3). This method was somewhat modified and with the method adopted it was found possible to determine the number of crystals in unit volume of a sugar syrup with all the necessary accuracy in about ten minutes. The counting method developed will be described elsewhere in detail.

2. *The Effect of the Degree of Supersaturation of Sugar Syrups on Crystal Numbers.*

The possibilities of "shock" graining syrups in cases where the concentration can be followed with the Zeiss Industrial Refractometer have already been indicated (2). It was shown that a cane syrup commences to form crystals spontaneously when the coefficient of supersaturation of the solution reaches about 1.3. The concentration of sucrose in solution which corresponds to any given supersaturation can be calculated from the formula:—

$$W = \frac{100\ R}{L_t\ C_1\ C_2 + R}$$

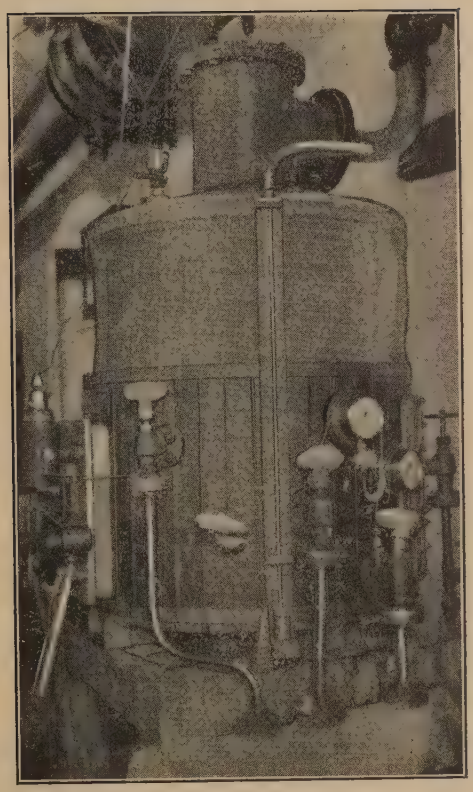

Plate XII.

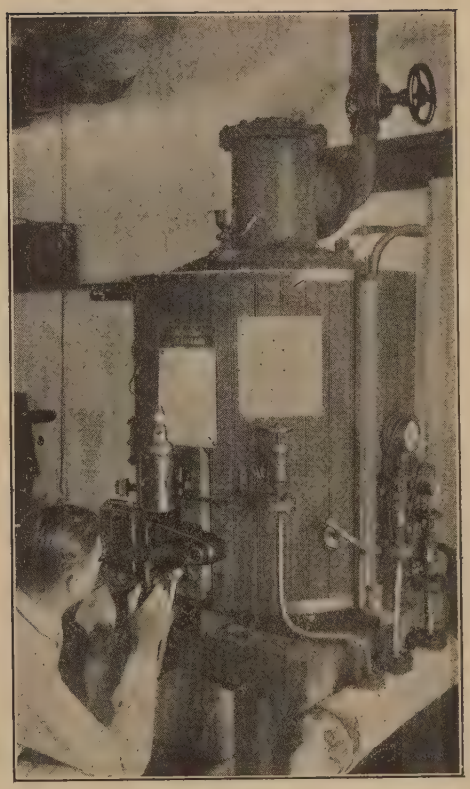

Plate XIII.

Where R = purity of syrup, L_t = solubility of sucrose in water at t°C., C_1 = saturation coefficient at purity R and C_2 = coefficient of supersaturation.

If the syrup is boiling under reduced pressure and the concentration and temperature are known, the pressure can be calculated since the concentration of the syrup, its boiling point and the pressure are connected variables. For reasons advanced elsewhere (4) it is better to work with pressure or "vacuum" rather than temperature when using the Zeiss Industrial Refractometer in practice.

In drawing up tables for "shock" graining, graphs for supersaturations of 1.3 and the desired supersaturation should be made, showing the relationship between "vacuum" and concentration. Fig. 1 gives two graphs connecting "vacuum" and concentration for supersaturations of 1.3 and 1.55 for a cane syrup of 86.0 optical purity. Tables are then readily constructed for the use of the pan boiler by interpolation from these graphs. For instance, Table I. has been drawn up from the curves featured in Fig. 1. This table has been used successfully for "shock" graining at Carrington Factory.

TABLE I.

"SHOCK" GRAINING CANE SYRUPS.

Optical Purity of Syrup 86.0.
Supersaturation raised to 1.55.

Vacuum in Pan	24½"	25"	25½"	26"
Raise concentration to (supersaturation 1.3) ..	82.1	81.7	81.3	80.8
Lower Vacuum to ..	20"	20½"	21½"	22"
Raise concentration to ..	84.9	84.5	84.1	83.7
Raise Vacuum to and then charge ..	24½"	25"	25½"	26"

Tables such as these were made out for supersaturations of 1.5; 1.55; and 1.6 and syrups were grained, according to these tables, in the small pan by suitable manipulation of the vacuum and with the aid of the Industrial Refractometer.

An important factor affecting the crystal numbers is the time taken for the supersaturation of the syrup to rise to the higher supersaturation, i.e., the time taken for the "vacuum" to increase from say 20½" to 25" since it is during this period that crystals are forming. As soon as the higher vacuum is reached, dilute syrup is run into the pan and further crystallisation is prevented.

In operating the small pan it was found difficult to keep this time constant and hence the results of the crystallisation experiments are not as consistent as they might have been. The reason was that, in order to keep the prism of the refractometer covered in the small pan, it was necessary to have at least 65% of the volume of the pan filled with syrup. When the vacuum is raised, the syrup boils violently and more or less syrup frothed up into the vacuum pipe with the result that the vacuum rose less quickly than it should have done. In order to eliminate this difficulty a belt was made and fitted and the capacity of the pan was thus increased. Plate XII. shows the pan after the belt had been added. Unfortunately, there was very little time available to utilise the pan after the belt had been attached.

The results obtained in the graining experiments are set out in Table II. and indicate quite clearly the dependence of the number of crystals on the induced supersaturation.

TABLE II.

Number of crystals formed at different supersaturations in the ' 'shock" method of graining.

Supersaturation.	Number of crystals formed per cc.			
	No. of Expts.	Mean.	Minmum.	Maximum.
1.3 — 1.5	4	140,000	47,000	176,000
1.3 — 1.55	3	259,000	198,000	322,000
1.3 — 1.6	2	372,000	241,800	501,400

3. *The Effect of Purity of Syrup on Crystal Formation.*

A preliminary study was made of the Walker (5) method of boiling in which only one grade of molasses (56 apparent purity) is produced. This grade of molasses is boiled directly into a final massecuite without utilising any high purity syrup.

In connection with this investigation an attempt was made to grain this type of molasses directly in the pan. In practice this grain can be discharged into a crystallising tank and be taken back into the pan as desired.

Some molasses of 60 optical purity was treated with steam and brought to a reaction corresponding to pH 7.0 by the addition of washing soda. Under the microscope no crystals could be detected in this molasses on taking into the pan. The molasses was concentrated down, the requisite data were recorded, and samples were taken every thirty seconds for examination under the microscope. When crystals were first detected the supersaturation of the molasses was calculated and found to be 1.35. Concentration of the molasses was continued and a very even batch of crystals was formed. The crystals were very small but on leaving the molasses over night, it was found that they had grown appreciably.

In certain experiments to be described subsequently it was necessary to make up a pure sucrose solution. As a matter of interest, this syrup was concentrated down to determine the supersaturation at which spontaneous crystallization would commence. It was found that crystallisation took place at a supersaturation of about 1.30.

From these experiments and those described elsewhere (2) it appears that the purity of a cane syrup has little or no effect on the supersaturation at which spontaneous crystallization takes place. It should be mentioned, however, that this will only hold so long as the viscosity of the syrup is not sufficiently great to retard crystallisation. With a low purity molasses a much higher concentration of total solids is needed to obtain the same supersaturation of sucrose in solution, and means must be taken to reduce the viscosity as much as possible. In an attempt to grain a molasses of approximately 56 apparent purity which had not been treated with steam and washing soda and which was acid and viscous, it was found that crystals did not form until a supersaturation of nearly 1.6 was reached.

4. *The "Washing Out" of Small Crystals.*

The problem of dissolving out fine grain in pan boiling sometimes arises. This fine grain may have been formed through carelessness in the actual boiling process or too many crystals may have been made during graining.

In either case, the excess crystals can be easily removed with the aid of the refractometer and suitable manipulation of the vacuum. The method adopted was to calculate the necessary data and then to draw graphs connecting concentration and vacuum for a supersaturation of 1.1 and an undersaturation of 0.95. The graphs are used in the same way as similar curves are used in "shock" graining. In this case, syrup is run into the pan until the supersaturation of the mother liquor is reduced to 1.1; the vacuum is then lowered until the prevailing concentration of mother liquor will give an undersaturation of 0.95. This can be read off from the graph. When the syrup becomes undersaturated the crystals immediately begin to round off and, as soon as the fine grain has disappeared, the vacuum is raised to its original value. A mild supersaturation of sucrose is thus restored in the mother liquor, and whilst the washing action is immediately stopped, there is no danger of forming a fresh batch of crystals.

This method was used successfully in the small pan. It was found that, in forming an initial batch of crystals in syrup, a very good grain could be obtained by definitely forming more crystals than needed and then washing out the finer ones by the method outlined above.

5. *The Elevation of the Boiling Point of Sucrose Solutions.*

The elevations of the boiling points of sucrose solutions of various concentrations given by Geerligs (6) are those determined by Gerlach (7). Deerr (8)

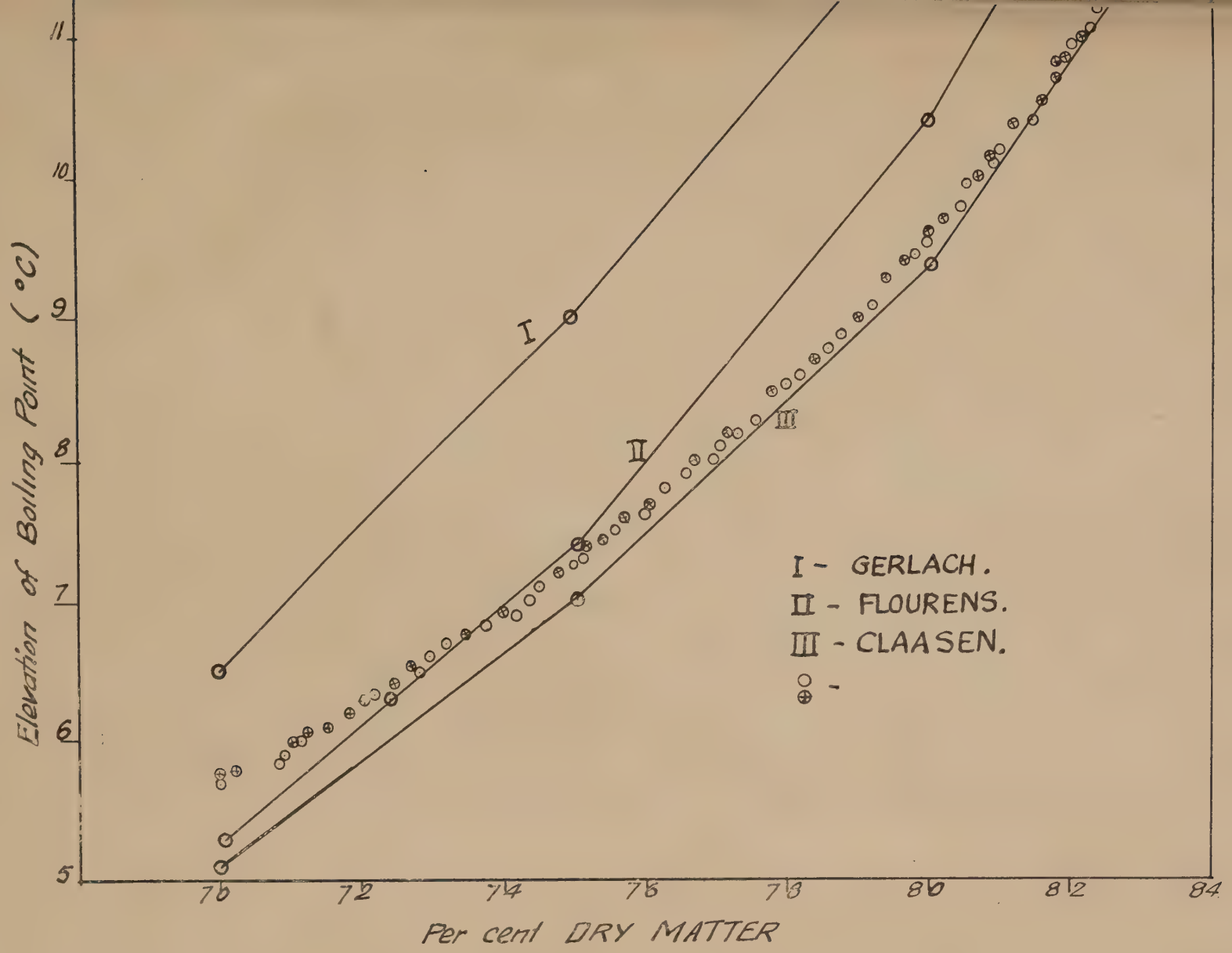
Elevation of Boiling Point (°C)
11
10
9
8
7
6
5
I
II
III
I - GERLACH.
II - FLOURENS.
III - CLAASEN.
70
72
74
76
78
80
82
84
Per cent DRY MATTER

FIG 2

gives a table of the boiling point elevations, the values from 10 to 70% of which are due to Gerlach whilst the values from 75 to 92% are stated to be due to Claasen. Reference to Claasen's paper (9), however, indicates that the values from 75 to 92% are due to Flourens (10) and not to the figures obtained by Claasen-Herrmann.

The values of the boiling point elevations of the more concentrated solutions of sucrose given by Gerlach, Flourens and Claasen-Herrmann are different. In view of these differences and since an accurate knowledge of the elevation of the boiling points of sugar syrups is of considerable importance in the scientific control of pan boiling, it was thought desirable to re-determine these boiling points. The small pan fitted with the refractometer, allowing changes of concentration to be followed, and permitting the boiling to be performed under a reduced pressure which could be accurately determined, is capable of rendering much more accurate results than the apparatus in the earlier determinations.

The small vacuum pan was equipped with an accurate and tested thermometer and the pressure inside the pan was maintained constant and registered with a mercury manometer. Syrup was run into the pan and evaporation was effected slowly by controlling the pressure of steam in the heating coils and the temperature and concentration of the boiling syrup were recorded. In the time available it was only possible to determine the elevation of the boiling point of a pure sucrose solution over a range of concentrations of 69—83%. The data obtained together with those given by Gerlach, Flourens and Claasen-Herrman have been expressed in Fig. 2. It is evident that the data obtained is most in agreement with that of Claasen-Herrmann.

It is hoped to continue this work and extend it by the determination of the boiling point elevation of cane syrups of varying purities during next crop season.

6. *Demonstration of the Use of the Zeiss Refractometer in Pan Boiling.*

Demonstrations were given at Carrington Factory to show how the Zeiss Refractometer can be used to "shock" grain a sugar syrup, to grow the crystals so formed and to wash out fine grain. These demonstrations were well attended; representatives of fourteen vacuum pan factories were present.

Refractometers were installed this year at three vacuum pan factories in Barbados and have been used successfully.

(B) CRYSTALLISATION-IN-MOTION OF LOW PURITY MASSECUITES.

It was intended to continue and extend the investigations described under this head in last year's report during the past crop season, but pressure of other work has prevented much that was planned from being accomplished. A crystalliser at Sandy Lane Factory was provided with coils so that hot or cold water could be circulated through the massecuite. The massecuites in this crystalliser were kept at about 70°C. for twelve hours and were then rapidly cooled by the circulation of cold water. This was suggested on theoretical grounds in last year's report. Satisfactory results are reported as the result of this procedure, but it was not possible to make any investigation of the supersaturations of the mother liquor at different times.

Determinations of the supersaturations of the mother liquor of a C.Massecuite during cooling in the crystalliser were made at Carrington Factory. The figures obtained are given in Table III. and it may be noted that these are very similar to those obtained last season.

TABLE III.

SUPERSATURATIONS OF MOTHER LIQUOR OF A FINAL CRYSTALLISER MASSECUITE.

Time.	Dry Matter.	True Purity.	Temperature of Massecuite °C.	Coefficient of Supersaturation.	Per cent. Crystal Sugar.
At striking ..	86.32	51.77	68°	1.288	24.71
2 hours later ..	85.54	50.54	66°	1.221	26.34
12 " " ..	85.23	47.94	60°	1.227	29.53
24 " " ..	84.47	45.57	52°	1.205	32.17
37 " " ..	83.81	44.02	46°	1.195	33.76
48 " " ..	83.37	43.71	42°	1.191	34.10
60 " " ..	83.86	43.04	38°	1.265	34.70
71 " " ..	83.88	42.27	36°	1.273	35.93
88 " " ..	83.45	41.13	33°	1.244	36.57
*110 " " ..	*82.34	41.12	31°	1.165	36.58

* Water was stirred into the massecuite before curing.

The supersaturation of the mother liquor of these low purity massecuites remains almost constant during the whole of the time they remain in the crystalliser. The increase in crystal sugar which takes place is due entirely to the fall in temperature and consequent decrease in solubility of the sucrose in solution. It may be also noted that after the addition of water to facilitate curing, the supersaturation of the mother liquor is still about 1.15 indicating that more water could have been added without fear of crystal dissolution.

(C) MUSCOVADO SUGAR.

Muscovado sugar is still manufactured by a number of factories in Barbados. The output of muscovado sugar is to a large extent dependent on the demand for what may be termed the bye-product, choice molasses. On the average, about 6,000 tons of muscovado sugar and 800,000 gallons of choice molasses are produced annually in Barbados.

The control of muscovado sugar manufacture in Barbados of which the most important operations are the clarification of the juice and the boiling of the syrup is entirely empirical and depends on the skill and experience of the native operators. The possibilities of controlling the two operations mentioned by scientific rather than empirical methods have been investigated.

The correct reaction of the clarified juice is of importance both in the boiling of the syrup and in the subsequent crystallisation. If too much lime is used, dark coloured compounds are formed in the syrup during boiling. These compounds appear to be mainly decomposition products of hexose sugars, and their presence in the syrup results in a dark coloured muscovado sugar. On the other hand, if too little lime is used and an acid juice is boiled, more or less inversion of sucrose takes place according to the degree of acidity of the juice. The result is a smaller recovery of sugar with a proportionately greater amount of molasses.

The correct liming of the juice can be readily ascertained with a comparator pH set. This method of controlling clarification which has been in recent years very generally adopted in raw sugar factories, was introduced into one factory, and by the end of the crop season, as the result of requests, ten sets had been made up and distributed to other muscovado plants. The optimum pH for the clarified juice in muscovado sugar manufacture appears to be about 7.2.

The next skilled operation in muscovado sugar manufacture is the boiling of the syrup in the Aspinall pan. The native boiler judges the concentration of the syrup and the point at which to strike the pan by eye. The optimum concentration for the "sling" will depend chiefly on the purity of the syrup and the main factor which normally affects the purity of the syrup is the reaction of the clarified juice. As the pan boiler says "Lime low, boil high" and "Lime high, boil low." In other words, the pan boiler has to allow, in judging the concen-

tration at which to strike his pan, for the possible effect of inversion of sucrose due to low liming. This factor, however, can be ruled out in those plants where the reaction of the clarified juice is controlled by measurements of the hydrogen ion concentration and the problem is simplified to one of following the concentration of the boiling syrup in the pan.

It is not an easy matter to follow the concentration of the syrup in the Aspinall pan directly, but a simple indirect method can be used. The sugar syrup is boiling at atmospheric pressure, and since the boiling points of sucrose solutions of different concentrations are known, it follows that the temperature at which the syrup is boiling can be used as a measure of the concentration of sugar in solution.

At the factory where these investigations were carried out, thermometers were placed in two Aspinall pans, and it was found that the pan boiler almost invariably struck the pan when the temperature of the syrup was 230° F. This temperature therefore measures the concentration which this particular man judges to be the optimum one.

An accurate control of the concentration of the syrup in the pan opens a number of possibilities in the improvement of muscovado sugar manufacture. The main object in making muscovado sugar is to produce a large grained, good coloured sugar from which the molasses is readily separated at the centrifugals. A better grained sugar could be made if the first strike was discharged into several oscillators at a relatively high concentration and was cooled rapidly. This could be called the "graining" strike. Subsequently, the syrup can be less highly concentrated and discharged into the oscillators which contain grain. The cooling of this syrup should be slower with the object of encouraging the growth of the already existing crystals and preventing, as much as possible, the formation of new crystals.

(D) FANCY MOLASSES.

An average of about 6,000,000 gallons of fancy molasses are exported from Barbados every year. Fancy molasses is made by direct evaporation of cane juice and the outstanding problems in manufacture are the removal of "mud" or sediment and the inversion of sufficient sucrose to prevent crystallisation of the concentrated syrup.

In order to remove as much "mud" as possible by chemical means, it is necessary to clarify the raw juice with lime. Such a proceeding, however, lowers the hydrogen ion concentration and usually results in a syrup from which sucrose crystallises on keeping. It is therefore a common practice in Barbados to use little, if any, lime and to rely on cleaning the juice by skimming the boiling syrup in open pans.

Experiments have been carried out at a typical syrup plant with the object of improving the general method of manufacture adopted in Barbados. As the result of these experiments, the following scheme of manufacture has been drawn up.

The juice from the mills is limed so that the reaction of the clarified juice is between pH 6.0 and 6.2. It was found that efficient clarification could not be obtained with less lime than that recommended.

After clarification, cane juice vinegar is added to the juice until the reaction is brought down to about pH 4.5. The degree of acidity to which the juice should be brought will vary somewhat from factory to factory since the hydrogen ion concentration of the juice is only one of the factors which controls the amount of inversion of sucrose in solution. The time of boiling and the temperature of the juice are other factors affecting inversion, and these vary from factory to factory. The reaction of the juice must be sufficiently acid to bring about the required amount of inversion during the boiling process.

After the juice has been finally concentrated in the Aspinall pan, the syrup, whilst still hot, should be passed through some type of centrifuge which will remove all suspended matter. Laboratory experiments with a Sharples Supercentrifuge have shown that a very brilliant syrup can be obtained in this way. Investigations were carried out at a syrup factory to determine the value of a "Vicker" centrifuge for cleaning syrup. The results of the experiments undertaken with this particular machine have shown that the capacity is not large

enough to deal with the amount of sediment in syrup. The bowl appears to have a maximum capacity of about 4 lb. mud, and this amount was removed after passing syrup through the centrifuge for 15 minutes. The machine had then to be taken down and cleaned and usually about 30 minutes had elapsed before it was again in operation. This is a serious disadvantage and there is no doubt that a self-cleaning centrifuge would be most suitable for removing suspended matter from syrup.

It was further found that after passing syrup once through the centrifuge, 25–50% of the sediment was removed; after passing twice through the centrifuge another 25–50% of the remaining sediment was removed. With this type of centrifuge it would therefore be necessary to have three or four in series in order to effectually clean the syrup.

In the method of manufacturing fancy molasses outlined above, it is proposed that the correct degree of acidity in the clarified juice shall be obtained by the addition of cane juice vinegar. Mr. C. A. Coppin is investigating the possibilities of manufacturing acetic acid from cane juice by the "Quick Vinegar" process. An account of his experiments follows.

(E.) AN INVESTIGATION INTO THE MANUFACTURE OF VINEGAR FROM CANE JUICE.

(C. A. COPPIN, B.A. Sc.)

The method usually employed to obtain the requisite acidity for the inversion of sucrose in cane syrup manufacture, consists at present in allowing a relatively large quantity of cane juice to become sour. Fermentation and acetification is spontaneous; inoculation occurring by yeasts and bacteria from the atmosphere.

The acidity obtained is low, seldom exceeding 0.5 per cent. of acetic acid, and, consequently, large quantities of juice are required, which involves correspondingly large storage requirements. To attain a concentration of about 5% acetic acid in the juice several weeks would be required.

This investigation was made in an endeavour to arrive at a method whereby a relatively small quantity of strong acetic acid (e.g. 5 — 6%) could be obtained from cane juice in the shortest possible time.

The conversion of the sugars of cane juice into acetic acid takes place in two main stages:

1. Alcoholic fermentation by yeast.
2. Oxidation of alcohol to acetic acid by bacteria.

As simultaneous alcoholic and acetic acid fermentations had hitherto proved unsuccessful (Mitchell (11)), it was thought desirable to obtain an optimum alcoholic fermentation before acetification took place.

Hansen had clearly demonstrated the technical importance and superiority of the use of pure yeast cultures in alcoholic fermentations—hence the investigation involved:—

(1) The selection of a pure culture of yeast capable of rapidly fermenting cane juice.

(2) The determination of the optimum working conditions for this yeast.

The method of yeast selection followed was that outlined by Fowler (12).

The sterile nutrient gelatine on which the cultures were grown was made up as follows:

Gelatine	175 grams
Glucose	100 "
Ammonium sulphate	1 "
Calcium dihydrogen phosphate	0.1 "
Potassium sulphate	0.1 "
Concentrated H_2SO_4	0.5 ccs.
Water	to one litre.

The yeast for inoculating this medium was obtained from a sample that had developed spontaneously from the atmosphere in fresh cane juice.

Twenty-five cultures were obtained and of these eleven were eventually selected for growth in cane juice.

The rate of fermentation of the different cultures was ascertained by following the Brix hydrometer readings over time intervals and "Blanks" were made to ensure that contamination with outside yeasts had been eliminated.

A number of preliminary experiments had made it evident that the nutrients of the cane juice were insufficient to maintain vigorous fermentation.

A nutrient solution was made up as follows:

Ammonium sulphate	100 grams
Calcium di-hydrogen phosphate	5 "
Potasium sulphate	10 "
Water	to 1 litre

Table IV. illustrates the effect of the above nutrients on rate of fermentation.

TABLE IV.

		Brix after 20 hours.			Brix after 48 hours.		
	Original Brix.	No Nutrients.	1% Nutrients.	2% Nutrients	No Nutrients.	1% Nutrients.	2% Nutrients.
No. 4 Yeast.	14.5	11.8	11.4	11.0	7.3	3.4	2.8
No. 7 "	14.5	10.0	9.4	10.0	7.0	1.2	3.6
No. 10 "	14.5	10.0	9.4	10.0	7.2	1.2	3.0
No. 12 "	14.5	11.8	11.0	10.0	8.4	2.4	3 6

Further experiments indicated that nutrients exceeding 1.5% served no useful purpose; indeed, 4% of the above nutrient solution retarded fermentation.

The effect of a varying hydrogen ion concentration on the rate of fermentation was next studied. The correct reaction in each case was obtained by addition of dilute sulphuric acid. The optimum alcoholic fermentation took place between p H 4.5–4.8.

Experiments were now conducted in which the selected yeasts were grown under optimum conditions. Table V. shows the results obtained.

TABLE V.

Brix of original juice 14.8; pH 4.5.
Nutrients 1% by volume.
Inoculated with 1% by volume pure yeast culture.

DEGREES BRIX AFTER.

	10 hrs.	20 hrs.	30 hrs.	40 hrs.
No. 1 Yeast	14.6	10.5	5.2	0.6
" 2 "	14.8	11.5	6.0	3.4
" 3 "	14.6	10.7	5.8	3.0
" 4 "	14.8	11.9	6.2	3.4
" 5 "	14.4	10.4	5.6	2.2
" 6 "	14.2	10.4	5.2	0.6
" 7 "	13.9	9.7	5.0	1.2
" 8 "	14.4	11.5	5.6	2.4
" 9 "	14.8	11.9	6.9	4.0
" 10 "	14.5	10.4	5.4	1.2
" 11 "	13.9	9.7	4.5	0.0
" X " from air	14.2	11.6	6.8	2.4

From the above Nos. 11, 1, 6, 7, 10 were finally selected and preserved in pure 10% Sucrose solution. The above yeasts were grown repeatedly, and at different temperatures. The result of the experiments indicate that:—

(1) Under optimum conditions as above, and at ordinary temperature (84° F.) No 11 yeast is capable of fermenting an average cane juice of 15 Brix to 1.5 Brix with the accumulation of 5.8% by volume alcohol in 24 hours.

(2) Nos. 6 and 7 appear to be similar yeasts and produce the same results in 30 hrs.

(3) 100 gallons of cane juice having pH 5.6 and Brix 15.0 will require for rapid fermentation, the addition of:—

1 lb. Sulphate of Ammonia
1 oz. Superphosphate
2 oz. Sulphate of Potash
3 oz. Commercial Sulphuric Acid.

In practice this quantity of cane juice would be inoculated at ordinary temperature with 1 gallon pure culture yeast which would be supplied from the Department of Science and Agriculture. In 24 hours the fermented liquor would be ready for acetification.

Acetification of the Fermented Cane Juice.

Experiments on this process are in progress but they have not yet reached a sufficiently advanced stage for recommendations to be made. Attempts are being made to develop a "Quick Vinegar" process using the above fermented liquor.

SECTION II. THE COMPOSITION OF DIFFERENT VARIETIES OF SUGAR CANE.

A. ANALYSES CONNECTED WITH GENETICAL INVESTIGATIONS.

In connection with the selection of new seedling canes 5,110 samples were milled and determinations were made of sucrose and brix of the extracted juice. In the variety trials, 235 bundles of cane were crushed and samples of both juice and megass were analysed. All of these analyses are dealt with in more detail elsewhere in this report by the Geneticist.

B. ANALYSES CONNECTED WITH SOIL INVESTIGATIONS.

Walker (13) in Hawaii has, by the analysis of the juice, utilised the sugar cane as a means of determining deficiencies of phosphoric acid and potash in the soil. During the past three years the juice from selected varieties of sugar cane grown on the variety trial plots at the various stations has been analysed for potash and phosphate to determine the applicability of Walker's method to Barbados conditions. Ash analyses have also been made of the megass to determine the distribution of constituents between juice and megass and also to determine whether the analysis of the juice gives a sufficient accurate estimate of the analysis of the entire cane.

(1) *The Distribution of Nitrogen, Ash, Potash and Phosphate between Juice and Megass.*

In the three roller mill used in the crushing of the cane, between 65%—70% juice and 30%—35% megass are obtained.

In Table VI. are set out the mean analyses of the cane obtained from 26 centres in order to show the distribution between juice and megass for the three varieties Ba 11569, B 381, and B 417 for the years 1928–29 and 1929–30. The mean value for the three varieties is figured in Fig. 3.

These figures show that the distribution is similar for different varieties and different years. The constituents extracted in the juice will in all probability exist in solution in the cell sap of the cane, and Table VI. shows that of the total constituents in the cane:—

(1) over 50% more potash exists in the juice than in the megass.
(2) the phosphates are equally distributed between juice and megass.
(3) about 50% more ash and nitrogen exist in the megass than in the juice.

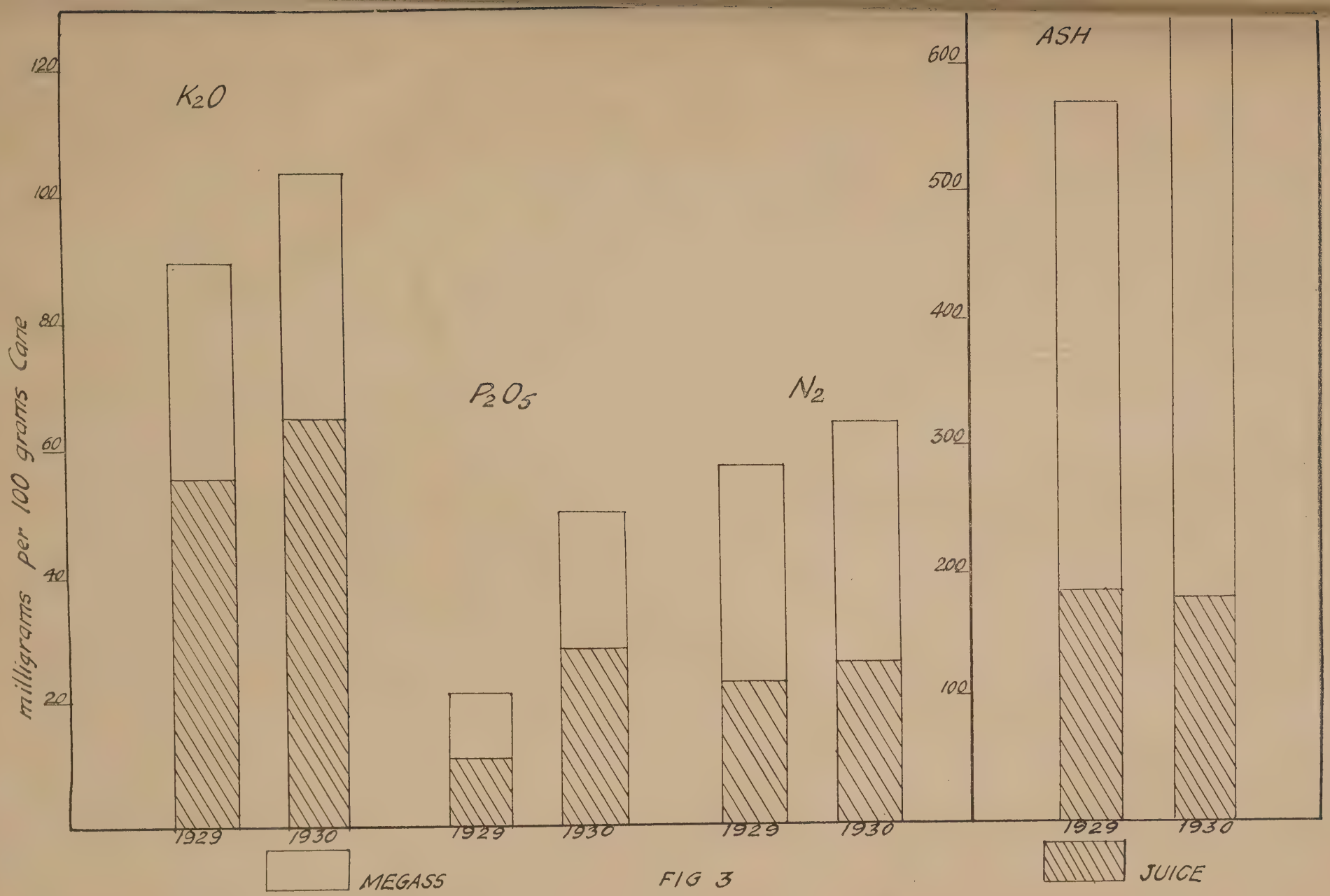
milligrams per 100 grams Cane
120
100
80
60
40
20
K_2O
P_2O_5
N_2
ASH
600
500
400
300
200
100
1929
1930
1929
1930
1929
1930
1929
1930
MEGASS
JUICE

FIG 3

TABLE VI.

Season.	Variety.	Grams K_2O in 100 grams cane.			Grams P_2O_5 in 100 grams cane.			Grams Ash in 100 grams cane.			Grams Nitrogen in 100 grams cane.		
		In Juice	In Megass	In Cane.	In Juice	In Megass	In Cane.	In Juice	In Megass	In Cane.	In Juice	In Megass	In Cane.
1928–29	Ba 11569	.0517	.0338	.0855	.0101	.0098	.0199	.1679	.2607	.4286	.0243	.0355	.0598
	B 381	.0494	.0332	.0825	.0101	.0105	.0206	.1771	.2493	.4264	.0205	.0359	.0563
	B 417	.0670	.0357	.1027	.0114	.0105	.0220	.2091	.2408	.4503	.0232	.0319	.0550
	Mean.	.0560	.0342	.0902	.0105	.0103	.0208	.1847	.2503	.4350	.0227	.0344	.0571
1829–30.	Ba 11569	.0583	.0355	.0938	.0277	.0203	.0480	.1655	.2600	.4255	.0275	.0414	.0689
	B 381	.0609	.0388	.0997	.0292	.0201	.0493	.1697	.2383	.4080	.0224	.0346	.0570
	B 417	.0757	.0483	.1240	.0287	.0258	.0545	.2046	.2753	.4799	.0261	.0403	.0664
	Mean.	.0650	.0409	.1059	.0285	.0221	.0506	.1799	.2579	.4378	0.253	.0388	.0641

(2) *The Correlation between Juice and Cane Analyses.*

The method of analysing the plant as a means of estimating the available nutrients in the soil was originally suggested by Hall (14) and has more recently been modified by Neubauer (15) since when this method has been the subject of considerable investigation. In the case of the sugar cane it is possible to obtain a sample of juice to represent any given area of soil since it is a simple matter to sample juice expressed from sugar cane at the mills. In utilising such a method, however, it is necessary to know whether the analysis of the juice is representative of the whole plant. The correlations between juice and cane analyses for three varieties over twenty-six centres have been worked out. The mean correlations obtained are set out in Table VII. and it will be seen that they are high. The variations in the anaylses of the juice of cane grown on different soils are therefore very similar to the variations in the anlysis of whole cane.

TABLE X.

Correlation between	Ba 11569	B 381	B 417
Ash in Juice and Ash in Cane ..	+0.8308	+0.7995	+0.7935
Potash in Juice and Potash in Cane ..	+0.8980	+0.9491	+0.9287
Phosphate in Juice and Phosphate in Cane ..	+0.9496	+0.9802	
Nitrogen in Juice and Nitrogen in Cane ..	+0.8138	+0.8318	+0.7702

(3) *The Differential Response of Varieties to Similar Soil and Climate Condition.*

This matter was dealt with in last year's report where it was shown that there are no significant differences between the ash, potash or phosphate content of the juices Ba 11569, B.H.10 (12) or B 381. It was shown, however, that the ash content and the potash content of the juices of B 417 and B 374 are significantly greater than the corresponding figures for Ba 11569 and B 381.

This matter has been further investigated and the results obtained in the crop season of 1929 confirm the previous figures obtained and show that the composition of the juice is a varietal characteristic. The statistical examination and the mean figures obtained for varieties grown at similar centres are given in Table VIII.

The variety White Transparent can be classified with B 417 and B 374 as having a significantly higher potash and ash content in the juice than Ba 11569. This variety has also a high percentage of nitrogen in the juice compared to the other varieties.

TABLE VIII.

NO. OF CENTRES 26.

	Varieties.			Diffs. %	Diff. ÷ Standard Deviation. "t"
	Ba 11569 %	B 417 %	B 381 %		
K_2O Juice ...	0.0753	0.0945		0.0192	*3.86*
	0.0753		0.0704	0.0049	0.98
		0.0945	0.0704	0.0241	4.84
	0.0154	0.0162		0.0008	1.27
P_2O_5 Juice	0.0154		0.0146	0.0008	1.27
		0.0162	0.0146	0.0016	*2.54*
	0.2473	0.3003		0.0530	*6.11*
Ash/Juice ..	0.2473		0.2567	0.0094	1.08
		0.3003	0.2567	0.0636	7.33
	0.0363	0.0309		0.0054	*2.44*
N/Juice ..	0.0363		0.0333	0.0030	1.36
		0.0309	0.0333	0.0024	1.09

Differences can be regarded as significant if "t" is greater than 2.06.

TABLE IX.

NO. OF CENTRES 18.

	Varieties.				Diffs. %	Diff. ÷ Standard Deviation "t"
	W. Trans.	Ba 11569 %	B 381 %	B 417 %		
K_2O Juice ...	0.0940	0.0792			0.0148	*2.38*
	0.0940		0.0737		0.0203	*3.27*
	0.0940			0.1061	0.0121	1.94
		0.0792	0.0737		0.0055	0.89
		0.0792		0.1061	0.0269	*4.33*
			0.0737	0.1061	0.0324	*5.21*
	0.0147	0.0151			0.0004	0.61
	0.0147		0.0155		0.0008	1.23
P_2O_5 Juice ...	0.0147			0.0159	0.0012	1.84
		0.0151	0.0155		0.0004	0.61
		0.0151		0.0159	0.0008	1.23
			0.0155	0.0159	0.0004	0.61
	0.3052	0.2571			0.0481	*4.88*
	0.3052		0.2578		0.0474	*4.79*
Ash/Juice ..	0.3052			0.3198	0.0146	1.47
		0.2571	0.2578		0.0007	0.71
		0.2571		0.3198	0.0627	*6.33*
			0.2578	0.3198	0.0620	*6.26*
	0.0433	0.0363			0.0070	*2.22*
	0.0433		0.317		0.0116	*3.67*
N/Juice ..	0.0433			0.0343	0.0090	*2.85*
		0.0363	0.317		0.0046	1.46
		0.0363		0.0343	0.0020	0.63
			0.317	0.0343	0.0026	0.82

Differences can be regarded as significant if "t" is greater than 2.11.

TABLE X.

	1927-28			1928-29			1929-30		
	Ba. 11569	B. 417	B. 381	Ba. 11569	B. 417	B. 381	Ba. 11569	B. 417	B. 381
	%	%	%	%	%	%	%	%	%
K_2O/Juice	0.0807	0.0965	0.0817	0.0753	0.0945	0.0704	0.0838	0.1089	0.0876
P_2O_5/Juice	0.0382	0.0399	0.0401	0.0154	0.0162	0.0146	0.0398	0.0413	0.0420
Ash/Juice	0.2832	0.3345	0.2795	0.2473	0.3003	0.2567	0.2381	0.2944	0.2441
Nitrogen/Juice	..	..	..	0.0363	0.0333	0.0309	0.0396	0.0375	0.0322
K_2O/Cane	..	..	..	0.0855	0.1027	0.0825	0.0938	0.1240	0.0997
P_2O_5/Cane	..	..	..	0.0199	0.0206	0.0220	0.0489	0.0545	0.0493
Ash/Cane	..	..	..	0.4286	0.4503	0.4264	0.4255	0.4799	0.4080
Nitrogen/Cane	..	..	..	0.0598	0.0550	0.0568	0.0689	0.0664	0.0570

(4) *The Differential response to similar Soil but different Climatic Conditions.*

It is now possible to give the average analyses for the three varieties Ba. 11569, B.417 and B. 381 for the three growing seasons 1927-28; 1928-29 and 1929-30. The analyses which are the means of about 26 centres are set out in Table X.

The results for the year 1929-30 verify the conclusion reached last year, viz., that the relative order in which the three varieties stand to one another in respect to the percentages of potash, phosphate and ash in the juice and, it can be added, in the cane is quite unaffected by climatic changes.

The percentages of phosphate in the juice and in the cane for the growing season of 1929-30 are again high as they were in 1927-28 and there seems little doubt that the percentage of phosphate in the juice and cane may vary considerably from year to year. It is not possible to analyse the effect of climate on the composition of juice at all accurately since it is difficult, if not impossible, to reproduce similar soil conditions over a period of years. The sugar cane has a growing season of about fifteen months and could therefore not occupy the same land for two successive years. In the figures given above the cane was generally grown on different fields at the same plantation in different years.

The mean percentage of potash in the juice of all three varieties for the growing season of 1928-29 is lower than for 1927-28 and 1929-30, but it is not possible to say whether this difference is a significant one.

The mean percentage of ash in the juice of all three varieties for the growing season of 1927–28 is higher than in the growing season of 1928–29 and 1929–30 and may be significant.

The possible effects of climate on the composition of the juice would seem to militate against the usefulness of such figures in determining possible deficiencies in the soil.

(5) *Ash Analysis of Sugar Cane as an Index of soil Deficiencies.*

a. Phosphoric Acid.

Walker (13) in Hawaii as the result of his investigations on the phosphoric acid content of cane juice comes to the tentative conclusions that soils yielding cane with a phosphoric acid content of more than 0.020% in the juice probably contain enough available phosphates; where the juice contains less than 0.020% P_2O_5 phosphates *may* be advantageous and where the juice contains less than 0.01% P_2O_5 the soil will probably respond to phosphatic fertilizers.

The ash analyses of cane juice which have been carried out in Barbados during the past three years show that in the season 1927-28 and 1929-30, 4 out of 192 juices contained less than 0.02% P_2O_5 and no juices contained less than 0.01% P_2O_5

In 1928–29, 84 out of 111 juices contained less than 0.02% P_2O_5 while 22 out of the 84 contained less than 0.01% P_2O_5 The juices referred to in this section were obtained from cane grown on the varietal plots which have been laid down at similar centres each year. If the phosphatic status of soils in Barbados be judged by the result of 1928-29 on Walker's standards, the conclusion would be reached that it would be advisable to apply phosphates on many soils. On the other hand the results of 1927-28 and 1929-30 indicate that the sugar cane on Barbados soils will not respond to phosphatic manures.

The various manurial trials which were reaped this year show clearly that the addition of phosphate to the coral limestone soils of Barbados has no effect in increasing the yield of cane.

The percentage of phosphoric acid and potash in the juice of cane grown on differently manured plots is set out in Tables XI and XII. It will be noticed that phosphatic manuring has neither increased the percentage of phosphate in the juice nor increased the total weight of phosphate removed by the cane per acre.

(*b*) *Potash.*

Walker (13) has suggested, as the result of his experiments that a cane juice containing less than 0.05% K_2O indicated the need of potash fertilisation and one containing 0.10% did not.

At Centre I. the canes on the plots Nos. 2, 5, 7 and 12 which received no potash definitely showed by appearance and yield that they were suffering from potash deficiency. On the other hand at Centre II. there was no significant response in yield of cane to potash manuring. Reference to Table XIII. shows, however, that the juice of the cane at Centre I. contained a greater percentage of potash in the juice than at Centre II. These results raise considerable uncertainty as to the value of the analysis of the juice in determining soil deficiencies. The application of phosphate and potash to the soil has, on the average, increased the percentage of potash in the juice. This increase may be due as much to the application of phosphate as to the application of potash since the juice from the cane grown on Plot 3 at Centres I and II., which received no phosphate have a similar percentage of potash in the juice as the cane from the potash plots.

It is interesting to note the high percentage of potash in the juice of the cane from Plots 4 at Centres I. and II. which received phosphate and potash manuring without nitrogen. At Centre III. the effect of adding phosphate to the soil appears to have raised the percentage potash in the juice by over 50%.

In view of the apparent effect of phosphate manuring on the percentage of potash in the juice and of the results at Centres I. and II., it does not appear as if determinations of the percentage of potash in the juice of cane will be a very accurate guide to the potash status of Barbados soils.

It would seem that a deficiency of potash in the soil has a much greater effect on the yield of cane and hence on the total amount of potash removed from the soil than on the percentage of potash in the juice.

6. *Final Conclusions.*

As the result of the investigations which have been carried out during the past three years, it is considered that analyses of the juice are of little, if any, value in Barbados as a means of assessing soil deficiencies. The reasons upon which the decision is based may be summarised as follows:—

(1) The percentage of potash in the juice of the cane depends very much on variety and this factor must be taken into consideration.

(2) The juice from similar varieties of cane grown in different years may vary considerably in composition especially in respect to phosphoric acid.

(3) Manurial trials show that cane growing on soil deficient in potash may have more potash in the juice than cane growing on soil not deficient in this constituent.

(4) Evidence has been advanced to show that phosphatic manuring may increase the percentage of potash in the juice.

(5) It appears that a deficiency of potash on the Barbados soils has a much greater effect on the yield than on the percentage of potash in the juice.

SECTION III.—MANURIAL TRIALS.

1. *Sugar Cane.*

Four different types of experiment which were laid out on cane planted in 1928 were reaped this year and each type will be treated separately.

(a) *Type 1.*

This trial which was duplicated at a black soil and a red soil centre consisted of nine different treatments; each treatment was replicated six times at each centre and the plots were laid out in the form of randomised blocks. The particulars of treatment, yield, etc., is set out in Table XIV. It is of interest to note that the order of the plots arranged according to the average yield is almost identical for black and red soil centres.

TABLE XI.

Plot.	Treatment lbs. per acre.			Centre I.				Centre II.			
	N	P_2O_5	K_2O	% P_2O_5 Juice.	Lbs. P_2O_5 removed per acre.	% K_2O Juice.	Lbs. K_2O removed per acre.	% P_2O_5 Juice.	Lbs. P_2O_5 removed per acre.	% K_2O Juice.	Lbs. K_2O removed per acre.
12	..	..	..	.0302	12.87	.0808	36.04	.0403	29.86	.0675	50.02
3	67	..	112	.0363	20.83	.0800	45.91	.0264	20.37	.0675	52.08
5	67	..	..	.0303	12.74	.0890	37.42	.0244	19.53	.0658	52.65
6	..	..	112	.0291	15.66	.0703	37.83	.0305	23.77	.0911	71.00
2	67	60	..	.0294	12.52	.0808	34.41	.0227	18.77	..	..
7	..	60	..	.0271	10.45	.0719	27.72	.0342	26.21	.0562	43.06
4	..	60	112	.0302	17.76	.1357	79.82	.0344	25.30	.0935	68.75
1	67	60	112	.0256	16.35	.0956	61.20	.0240	20.31	.0692	58.57
8	89	60	112	.0271	17.05	.0937	58.97	.0333	26.82	.0609	49.06
9	112	60	112	.0225	13.13	.0857	50.00	.0282	24.06	.0569	48.55
10	67	60	168	.0324	19.14	.1058	62.50	.0379	29.55	.0796	62.06
11	67	60	224	.0356	23.18	.0831	54.27	.0241	18.69	.0838	65.00

TABLE XII.

CENTRE III.

Treatment per acre lb			% K_2O in Juice.	lb. P_2O_5 removed per acre	% K_2O in Juice	lb. K_2O removed per acre	Yield Cane per acre Tons
N	P_2O_5	K_2O					
134	..	134	.0272	20.38	.0754	56.50	33.44
134	..	134	.0278	21.78	.0787	61.65	34.97
134	72	134	.0279	21.31	.1274	97.30	34.09
134	72	134	.0310	24.11	.1174	91.28	34.71

TABLE XIII.

CENTRES I. and II.

Average per cent. Potash in Juice.

	Plots receiving No Potash	Plots receiving Potash
Centre I	0.0826	0.0938
Centre II	0.0632	0.0753

TABLE XIV.

Plot	Treatment per acre.	Nutrients (lb) per acre.			Black soil yield per acre.	Red soil yield per acre	Mean yield.	Difference from plot 1.	Cost of manuring per acre.	Value of increment @ $4 per ton cane.
		N.	P_2O_5	K_2O						
					tons.	tons.	tons.	tons.	$	$
4	Trash +3½ cwt. N. +3 cwt. P. +3 cwt. K.	78	67	168	30.64	40.04	35.34	10.7	28.0	42 8
3	2 sq. Pen M. +4½ cwt. N +1 cwt. P. +1¾ cwt. K.	286	148	260	29.65	39 06	34.35	9.8	45.0	39.2
9	9 cwt. N. +2 cwt. P. +3½ cwt. K	202	67	196	29.38	39.55	34.32	9.7	45.2	38.8
2	4 sq Pen M.	369	228	323	27.11	38.50	32.80	8.2	44.8	32.8
6	1½ ton C.S.M. +1 cwt. K.	141	134	110	29.33	35.39	32 36	7.8	45.3	31.2
8	3½ cwt. N. +3 cwt. P. +3 cwt. K.	78	67	168	27.10	36.06	31.58	7.0	24.0	28.0
7	¾ ton Fish Manure	69	78	168	25.80	35.79	30.80	6.2	45.0	24.8
5	3½ tons Sheep Manure	106	67	138	26.02	33.39	29.70	5.1	45.5	20.4
1	Unmanured	0	0	0	22.41	26.72	24.56	0.0	0.0	0.0

Notes on Table XIV.

(1) Under Treatment: N = Sulphate of Ammonia.
P = Superphosphate.
K = Sulphate of Potash.
C.S.M. = Cotton Seed Meal.

(2) The costs of manuring are based on the following values which were current in 1923 when the manures were purchased:—

Sulphate of Ammonia	$68 per ton
Superphosphate	$32 per ton
Sulphate of Potash	$65 per ton
Pen Manure	5c. per 100 lb.
Sheep Manure	$13 per ton
Cotton Seed Meal	$28 per ton
Fish Manure	$60 per ton
Trash has been valued at	$ 4 per acre.

(3) The statistical analysis of the experiment shows that any difference in the mean yields greater than 2.8 tons per acre has a 20:1 chance of being due to difference in manurial treatment.

The following conclusions can be deduced from this experiment:—

(1) *The value of mulching under Barbados conditions.*

Plots 4 and 8 received identical treatment except that the young cane on Plot 4 was "trashed" in January 1929 when the soil was still wet after the rainy season whilst Plot 8 received no mulching treatment. The difference in the forwardness and greenness of the cane on the trashed and non-trashed plots was very marked by the end of the dry season, *i.e.*, by June, 1929, and the differences persisted throughout the growing season. The mean difference in yield is 3.7 tons of cane per acre which is very significant.

This result is a striking proof of the value of mulching under Barbados conditions. As will be shown later the yield of sugar cane in Barbados is mainly limited by the available water and every effort should be made to conserve soil moisture.

During the dry season the prevailing conditions of high winds and hot sun are very favourable to evaporation of water from the soil and, on most plantations, little is done to minimise this loss.

If trash is not available for mulching it would be a profitable investment even at present prices of cane to manure the sour-grass pastures in order to obtain extra material for this purpose. If sufficient grass is not available the surface soil between the young canes should be kept loose with harrows.

(2) *The economic value of pen manure.*

It is the general practice in Barbados to apply relatively enormous dressings of pen manure to sugar cane. The usual applications are between 20 and 70 tons per acre.

The value of pen manure for improving the cropping powers of soils is well known, but pen manure is expensive to make up and the question arises as to whether at present prices of cane, heavy applications of pen manure give economical returns.

According to analyses conducted at the Laboratory, a 30 ton cane crop removes about 43lb. nitrogen, 23lb. phosphoric acid and 74lb. potash per acre. 4 squares of pen manure, i.e. between 30 and 40 tons, supplies between 8—9 times as much nitrogen, 10 times as much phosphoric acid and between 4—5 times as much potash as this. Since the yield of cane in Barbados is limited by the rainfall, it is doubtful whether these enormous quantities can be economically recovered in the yield of cane. Such being the case, one would conclude on theoretical grounds that the manure bill on many plantations could be reduced if less pen manure were made up.

Reference to Table XIV. shows that Plot 2 received 4 squares (approximately 40 tons) Pen Manure per acre whilst Plot 3 receives 2 squares (approximately 20 tons) Pen Manure plus a dressing of artificials per acre. The manure on these plots was broadcasted and acted as a most efficient mulch during the dry season. It should be noted, however, that the mulching effect of the trash applied to Plot 4 was just as efficacious.

The yield of cane from Plot 4 which supplied, in the form of chemical fertilizers, 78 lb. nitrogen, 67 lb. phosphoric acid and 168 lb. potash was equally as good as the pen manure plots which supplied nearly four times as much of these constituents. The cost of the two treatments is seen to be very different. It is, of course, well known that the nutrients in pen manure are much less available than they are in chemical fertilizers and that the excess nutrients in the pen manure may become available to subsequent crops. These trials are being continued as ratoons and this residual value of pen manure may then become evident.

The conclusion must be reached that the practice of making up large amounts of pen manure and applying heavy dressings to sugar cane in Barbados cannot be supported on theoretical grounds and, at the present price of cane, is uneconomical.

The best practice is to make up sufficient manure to keep the stock dry and give smaller dressings per acre. The excess trash and sour grass can be applied direct to the land, preferably as a mulch.

(3) *What are the values of such "organic" manures as Cotton Seed Meal, "Fish Manure" and Sheep Manure?*

It is a popular opinion in Barbados that if pen manure cannot be applied to sugar cane in any year, then some kind of "organic" manure must be supplied. A number of so-called "organic" cane manures can be obtained locally, of which a popular brand of "compound fish manure" was used in these experiments. It should perhaps be pointed out that the fish manures on the local market are not true fish manures in the sense that they contain nothing but fish or fish residues, but are compound manures often containing in addition to other ingredients, sulphate of ammonia, superphosphate and sulphate of potash.

In these experiments cotton seed meal, fish manure and sheep manure were applied in amounts which were equivalent in cost to 4 squares pen manure or 2 squares pen manure plus a suitable dressing of artificials. The cotton seed meal which is deficient in potash was supplemented with sulphate of potash.

In order to assess the value of these manures a mixture of sulphate of ammonia, superphosphate and sulphate of potash was made up to approximate in composition to that of the fish manure. The cost of this mixture was about $21 an acre less than the cost of the others.

The yield results show that this mixture of artificials has given as good returns as the "organic" manures and the saving per acre is considerable.

These results show that there is no need to purchase expensive compound manures if pen manures is unavailable. A simple mixture of artificials is much cheaper and gives equally good returns.

(4) *What amounts of nitrogen, phosphoric acid and potash does the sugar cane need in Barbados?*

It is not possible to answer this question with any degree of accuracy, but it is proposed to draw attention under this heading to certain points which do not appear to be sufficiently appreciated.

The main factor limiting yield of sugar cane in Barbados is the water supply and, as there are few places where irrigation is economically sound, the amount and distribution of the rainfall will necessarily determine the yield of cane in any year.

The average rainfall in Barbados is about 70 inches for the sixteen months growing period and if it is assumed that 30% of this rainfall is effective, i.e., transpired by the plant, it can be calculated that the average yield of cane in Barbados will be 28 tons of cane per acre. This figure is calculated from Arrhenius figure (16) for the water requirements of the sugar cane which agrees with that of Leather, viz. 300 times the dry matter and from a 25% dry matter content for sugar cane. This calculated average yield agrees with that obtained in practice which indicates that the water supply is the main limiting factor. Endeavours to increase the yield of cane must therefore be directed towards increasing the percentage of "effective" to total rainfall rather than by increasing the manuring of the soil. It is obviously uneconomical to supply enough nutrients to produce a cane crop of 100 tons per acre when there is only sufficient water available to grow a 30 ton crop.

This matter is well brought out if the yields of Plots 4, 9 and 8 are compared. These plots received sulphate of ammonia, superphosphate and sulphate of potash, but Plot 9 received a dressing at the rate of 202 lb. nitrogen, 67 lb. phosphoric acid and 196 lb. potash per acre, whilst Plots 4 and 8 received 78 lb. nitrogen, 67 phosphoric acid and 168 lb. potash. The extra cost of manure on Plot 9 over Plot 8 was $21 per acre and the increase in the mean yield was 2.7 tons per acre which has rather less than a 20:1 chance of being significant. It can be confidently stated that the increase in yield is insufficient to pay for the extra cost of manure. Plot 4 received the same amounts of nitrogen, phosphoric acid and potash as Plot 8, but an attempt was made to increase the "effective" water by mulching. The yield from Plot 4 is greater than from Plot 9 although the difference cannot be regarded as significant. The significant difference of the yield of Plot 4 over Plot 8, however, shows that the conservation of water

under Barbados conditions, is economically more effectual in increasing the yield of cane than an increase in the manure.

(*b*) TYPE II.

This trial was also duplicated at red and black soil centres and consisted of twelve different treatments. Each treatment was replicated six times at each centre and the plots were laid out in the form of randomised blocks. No pen manure was applied to these plots but they were all trashed in January. Nitrogen at the rate of 22 lb. per acre and all the potash and phosphates were applied in January. The remaining nitrogen was applied in July at the advent of the rainy season. This is the customary estate practice. The particulars of treatment and yield are set out in Table XV.

TABLE XV.

Plot.	Nutrients (lb.) per acre.			Red Soil Centre.		Black Soil Centre	
	N.	P_2O_5	K_2O	Yield per acre tons.	Diff. from plot 12 tons	Yield per acre tons.	Diff. from plot 12 tons.
1	67	60	112	28.5	+8.6	37.8	+4.7
2	67	60	–	19.0	–0.9	36.9	+3.8
3	67	–	112	25 6	+5.7	34.4	+1.3
4	–	60	112	26 3	+6.4	32.8	–0.3
5	67	–	–	18.8	–1.1	35.7	+2.6
6	–	–	112	24 0	+4.1	34.8	+1.7
7	–	60	–	17.2	–2.7	34.2	+1.1
8	89	60	112	28.1	+8.2	36.0	+2.9
9	112	60	112	26.0	+6.1	38.1	+5.0
10	67	60	168	26.4	+6.5	34.8	+1.7
11	67	60	224	29 1	+9.2	34.6	+1 5
12	–	–	–	19.9	0	33.1	0

NOTES ON TABLE XV.

(1) The nitrogen was supplied as sulphate of ammonia, the phosphoric acid as superphosphate and the potash as sulphate of potash.

(2) The statistical analysis of the experiments shows that any difference in the mean yields of the six replicate plots, greater than 4.3 tons at the red soil centre and 3.4 tons at the black soil centre, has a 20:1 chance of being due to difference in manurial treatment.

The following general deductions can be drawn from the results of this experiment:—

(1) At the red soil centre there is an obvious deficiency of potash in the soil and the plots receiving potash show a markedly significant increase in yield.

(2) At the black soil centre the soil on which the manurial plots were situated was evidently in "good heart." Only three plots show a significant increase in yield over the "no-manure" plot and it is evident that there is no response to potash on the soil.

THE EFFECTS OF NITROGEN ON THE YIELD.

The data of this experiment has been re-tabulated in Table XVI. in order to show more clearly the effects of nitrogen as sulphate of ammonia on the yield of sugar cane.

TABLE XVI.

Plot.	Treatment (lb.) per acre.			Red Soil Centre.		Black Soil Centre.	
	N.	P_2O_5	K_2O.	Diff. over unmanured.	Diff. between means of six plots.	Diff. over unmanured.	Diff. between means of six plots.
				tons per acre.		tons per acre.	
12	–	–	–	0.0		0.0	
5	67	–	–	-1.1	-1.1	+2.6	+2.6
7	–	60	–	-2.7		+1.1	
2	67	60	–	-0.9	+1.8	+3.8	+2.7
6	–	–	112	+4.1		+1.7	
3	67	–	112	+5.7	+1.6	+1.3	-0.4
4	–	60	112	+6.4		-0.3	
1	67	60	112	+8.6	+2.2	+4.7	+5.0
	Differences between means of 24 plots.				+1.1		+2.5
1	67	60	112	+8.6		+4.7	
8	89	60	112	+8.2	-0.4	+2.9	-1.8
1	67	60	112	+8.6		+4.7	
9	112	60	112	+6.1	-2.5	+5.0	+0.3

NOTES.

(a) A difference in yield between means of 6 plots has a 20:1 chance of being due to treatment if greater than 3.4 tons per acre at the red soil and 4.3 tons per acre at the black soil centre.

(b) A difference in yield between means of 24 plots has a 20:1 chance of being due to treatment if greater than 1.7 tons per acre at the red soil and 2.15 tons per acre at the black soil centre.

Reference to Table XVI. shows that the increased yield due to the addition of 67 lb. of nitrogen per acre as sulphate of ammonia on the cane at the two centres chosen can only be regarded as significant at the black soil centre.

It is evident that this is a maximum dose at these centres since an increase in the nitrogen application is without any effect on the yield.

(2) *The effects of potash on the yield.*

The effects of potash on the yield at the two centres is more clearly shown by reference to Table XVII.

TABLE XVII.

Plot.	Treatment (lb.) per acre.			Red Soil Centre.		Black Soil Centre.	
	N.	P_2O_5	K_2O.	Diff. over unmanured.	Diff. between means of six plots.	Diff. over unmanured.	Diff between means of six plots
				tons per acre.		tons per acre.	
12	..	...		0.0	+4.1	0.0	+1.7
6	...	...	112	+4.1		+1.7	
7	...	60	...	-2.7	+9.1	+1.1	-1.4
4	...	60	112	+6.4		-0.3	
5	67	...	...	-1.1	+6.8	+2.6	-1.3
3	67	...	112	+5.7		+1.3	
2	67	60	...	-0.9	+9.5	+3.8	+0.9
1	67	60	112	+8.6		+4.7	
	Differences between means of 24 plots.				+7.4		-0.1
1	67	60	112	+8.6	-2.1	+4.7	-3.0
10	67	60	168	+6.5		+1.7	
1	67	60	112	+8.6	+0.6	+4.7	-3.2
11	67	60	224	+9.2		+1.5	

NOTES.

(a) A difference in yield between means of 6 plots has a 20:1 chance of being due to treatment if greater than 3.4 tons per acre at the red soil and 4.5 tons per acre at the black soil centre.

(b) A difference in yield between means of 24 plots has a 20:1 chance of being due to treatment if greater than 1.7 tons per acre at the red soil and 2.15 tons per acre at the black soil centre.

At the red soil centre 112 lb. K_2O per acre has had a very marked effect on the yield. It is interesting to note, however, that even on this potash deficient soil, additions of 168 lb. or 224 lb. K_2O per acre do not result in further increases in yield. It is evident that 100 lb. K_2O per acre is ample for an average cane crop even on soils deficient in potash.

At the black soil centre, the application of potash has had no effect on the yield in any of the doses used.

(3) *The effect of phosphate on the yield.*

The effect of additions of 60 lb. phosphoric acid per acre is shown in Table XVIII. The differences in yield of cane due to additions of phosphate to the soil cannot be judged as significant at either the black or red soil centres.

TABLE XVIII.

Plot.	Treatment (lb.) per acre.			Red Soil Centre.		Black Soil Centre.	
	N_2	P_2O_5	K_2O	Diff. over unmanured.	Diff. between means of six plots.	Diff. over unmanured.	Diff. between means of six plots.
12	...	...	...	0.0	-2.7	0.0	+1.1
7	...	60	...	-2.7		+1.1	
6	...	...	112	+4.1	+2.3	+1.7	-2.0
4	...	60	112	+6.4		-0.3	
5	67	...	...	-1.1	+0.2	+2.6	+1.2
2	67	60	...	-0.9		+3.8	
3	67	...	112	+5.7	+2.9	+1.3	+3.4
1	67	60	112	+8.6		+4.7	
	Differences between means of 24 plots.				+0.67		+0.9

NOTES.

(a) A difference in yield between means of 6 plots has a 20:1 chance of being due to treatment if greater than 3.4 tons per acre at the red soil and 4.3 tons per acre at the black soil centre.

(b) A difference in yield between means of 24 plots has a 20:1 chance of being due to treatment if greater than 1.7 tons per acre at the red soil and 2.15 tons per acre at the black soil centre.

(*c*) TYPE III.

Soil analysis has shown that on many of the red soils overlying coral limestone in Barbados, no water soluble phosphoric acid can be detected. Analyses of cane grown on these soils, however, shows ample phosphate. A clear cut trial to test the effect of phosphate on the yield of cane on such a soil was laid down.. The plan of the experiment was on the A.B.B.A. method of Student and ten replicates of each treatment were taken. The basal manuring of the plots was at the rate of 134 lb. nitrogen as sulphate of ammonia, 134 lb. potash as muriate of potash per acre and trash was turned in to the soil. The B plots received in addition superphosphate at the rate of 72 lb. phosphoric acid per acre.

The results of the trial are given in Table XIX.

TABLE XIX.

Treatment.			Mean yield of 10 Replicates (tons) per acre.	Quotient of Purity of Juice.
N	P_2O_5	K_2O		
134	..	134	34.86	88.1
134	72	134	34.83	88.8

It is seen from Table XIX that there is no difference in yield as the result of adding phosphate to this soil. It was found that the standard error of the difference between means of 10 purities in this experiment was 0.76%, so that the difference of 0.7% is certainly not significant. From the results of this and the previous experiments reported on, it can be concluded with a fair degree of confidence that sugar cane growing on the coral limestone soils in Barbados will not respond to phosphatic manuring. This conclusion supports the results of Bovell's (17) manurial experiments carried out over a period of years at Dodds Plantation.

On theoretical grounds it would be expected that the need for phosphates would not be great in Barbados for the following reasons:—

(1) The soils in Barbados overlie and are largely derived from the coral limestone and would therefore be expected to be naturally rich in phosphate.

(2) The phosphate requirements of the sugar cane are low. A 30 ton crop of sugar cane takes about 23 lb. P_2O^5 from the soil per acre.

(3) Almost all of the phosphate extracted from the soil goes back to the arable land since the phosphate in the juice is precipitated in sugar manufacture and the "muds" are used for feeding to stock.

(4) It is a very general practice to use pen manure on arable soils in Barbados; hence there is a constant application of phosphate derived from the concentrated food fed to the stock.

(*d*) TYPE IV.

This experiment was planned to test the relative values of muriate and sulphate of potash for sugar cane on Barbados soils.

At present there is little muriate used in the island although the substitution of sulphate by muriate of potash would effect no inconsiderable saving in the manure bill. Barbados produces about 80,000 tons of sugar per annum which corresponds to about 27,000 acres of cane. If it is estimated that 80 lb. K_2O is added per acre, it can be calculated that 1929 tons 50% sulphate of potash or 1607 tons 60% muriate of potash would be needed to supply the potash requirements of this area. At the present time, muriatae of potash is selling at about $63 a ton and sulphate of potash at $65 a ton on the local market. It can be calculated from these figures that the substitution of sulphate by muriate will save about $24,000 or about £5,000 per annum on the potash bill.

This experiment was planned on the A.B.B.A. method of Student with ten replicates of each treatment. The plots received no pen manure but trash was turned in. 134 lb. nitrogen and 134 lb. of potash either as sulphate or muriate were given per acre. 30 lb. nitrogen and the 134 lb. potash were applied in January 1929; the remaining nitrogen was applied in July 1929.

The results of the experiment are set out in Table XX.

BARBADOS.
Scale 1 in = 2.21 miles.
Scotland soils.
Coral limestone soils.
TEXTURE MAP
SANDS (I.T. - 0-24)
LOAMS (I.T. - 25-39)

FIG 4

TABLE XX.

Plot.	Yield tons per acre.		Per cent. Sucrose in cane.		Quotient of Purity of Juice.	
	A Muriate.	B Sulphate	A	B	A	B
A1 and B1	35.51	39.14	15.87	15.29	87.8	87.1
B2 and A2	33.85	33.59				
A3 and B3	37.58	33.28	15.19	16.20	86.6	88.8
B4 and A4	27.84	32.24				
A5 and B5	35.10	33.96	15.90	15.68	88.8	88.4
B6 and A6	36.81	41.21				
A7 and B7	40.80	34.94	16.51	16.28	91.2	88.8
B8 and A8	40.38	38.72				
A9 and B9	30.43	36.55	16.56	16.90	88.4	89.4
B10 and A10	36.55	40.07				
Mean ..	35.48	36.37	16.01	16.07	88.56	88.50
Difference		+ 0.89		+ 0.06	+ 0.06	

Statistical analysis of the yield data shows that the standard error of the difference between the mean yields of the ten replicates is 1.23 tons. The difference of 0.89 tons between the mean yields of the muriate and sulphate plots is therefore certainly not significant.

It is also evident that the muriate of potash has had no effect on either the percentage sucrose in cane or on the quotient of purity of the juice.

From the result of this experiment there seems no reasons why muriate of potash should not be used to replace sulphate of potash in Barbados.

2. SOUR GRASS.

In Barbados, soil which is too shallow to grow sugar cane is planted in sour grass. These sour grass "pastures" are, mostly, at least fifty years old, and it is the recognised practice to cut the grass once or twice per annum. The grass is taken to the pens and what is not eaten by the stock is utilised as litter. It is not the custom to manure this grassland in Barbados with the result that the yield of grass is limited by the food which is rendered available in the soil each year.

In any study of possible improvements of the general agricultural practice in Barbados, the need of more organic matter for the soil is at once apparent. Such organic matter is needed for mulching purposes in the dry season and ultimately for increasing the stock of humus in the soil. The principal supplies of organic matter on the average plantation are trash, sour grass and, to a lesser extent, green catch crops. An obvious method of increasing the supply of organic matter is therefore to manure the sour grass. These experiments were put down with the object of determining the increased yield which would result from the application of manures.

The trial was laid out at red and black soil centres on typical sour-grass pastures in the form of randomised blocks with six replicates. The particulars of the experiment with the weight of grass obtained at the first cutting are given in Table XXI.

TABLE XXI.

Plot.	Treatment per acre.	Cost per acre. $	Yield of Grass.			
			Red Soil.		Black Soil.	
			Plot. 1. =100	lb. per acre.	Plot 1. =100	lb. per acre.
1	No manure.	0	100	2808	100	5324
2	1½ cwt. N. +2½ cwt. P. +1 cwt. K.	12.35	313.7	8810	185.4	9874
3	2 tons M. + 1 cwt. N. + 2 cwt. P.	14·10	212.0	5953	142.7	7600
4	1½ cwt. N. +2½ cwt. P.	9.10	313.7	8810	143.6	7648

NOTES.

N = sulphate of ammonia.
P = superphosphate.
K = sulphate of potash.
M = molasses.

At the red soil centre the complete manure and complete manure minus potash plots yielded over 300% more grass than the unmanured plot. At the black soil centre the complete manured plot gave a yield nearly 200% greater than the no-manured plot. At this centre there was a significant response to potash manuring. Molasses was used at both centres to supply part of the nitrogen and the whole of the potash, but it is evident from the yield results and cost that this treatment is not satisfactory for grassland in Barbados.

It should be noted that a second cutting of grass could have been easily obtained from the manured plots, but it was not found possible to make these cuttings. It can however be safely estimated that the completely manured plots would have given at least another 100% extra yield over the unmanured plots in the second cutting.

There seems little doubt as the result of these experiments that the typical Barbados sour grass pasture will give an increased yield of between 300–400% as the result of judicious manuring. Sour grass pastures are rented at about $10 per acre, and since a complete dressing of manure will cost about $12.00 per acre and the yield of grass will be as great as was formerly given by 3 or 4 acres, it is obviously an economic proposition.

SECTION IV. SOILS.

In a small country such as Barbados where the soil types are few and where there is almost no uncultivated land, it is evident that an intensive type of soil survey is most suited to local conditions. With the aid of manurial trials and soil analyses the intention has been to build up a system whereby advice can be given to the individual planters on cultivation and manuring. This section indicates how far this work has proceeded.

The major part of the soils of Barbados is situated on and mainly derived from the Coral Limestone formation. These "coral limestone" soils can be grouped into three main divisions:—

(1) The Black soils—distributed at the lower altitudes; mainly below 500 ft.
(2) The Red soils—distributed at the higher altitudes; mainly above 500 ft.
(3) The Red Sand Soils—distributed over a long narrow area on the Leeward side of the island.

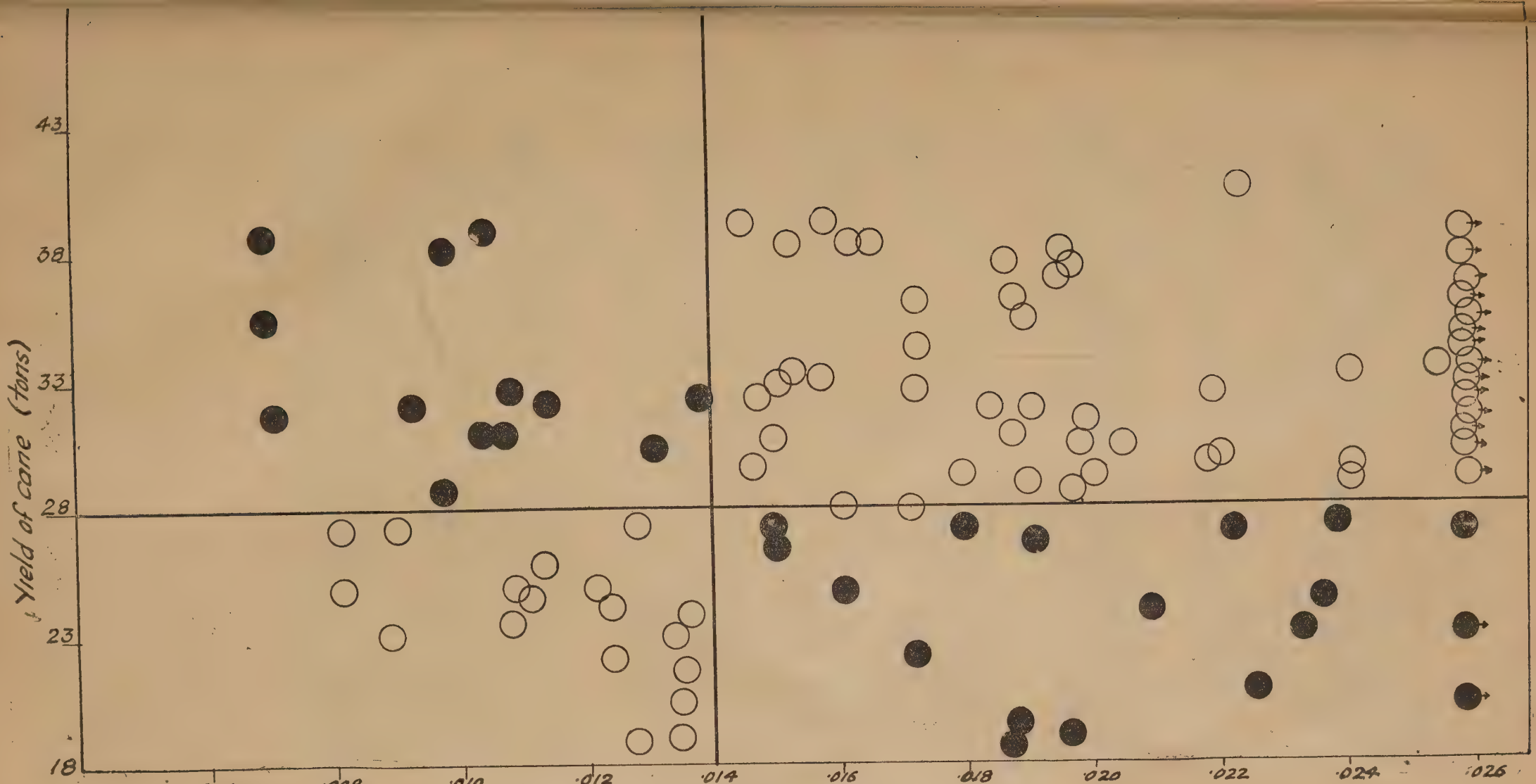
43
38
33
28
23
18
Yield of cane (tons)
·006
·008
·010
·012
·014
·016
·018
·020
·022
·024
·026
Per cent Exchangeable Potash in Soil

FIG. 5

The remaining soils which are situated in the Scotland area are derived either from the Oceanic or from the Scotland formation, and appear much more heterogeneous in character.

Fields have been sampled on only four plantations in the Scotland district, and it is therefore not possible to generalise, at present, on the soils in this area.

The approximate areas of arable acreage in Barbados which fall into the above classification are as follows:—

Coral Limestone Soils	(1) Black	36,000 acres
	(2) Red	18,000 acres
	(3) Red Sand	1,500 acres
Scotland Soils		4,000 acres

The following notes illustrate the main features met with in the investigations, which have so far been undertaken on Barbados soils.

1. PHYSICAL TEXTURE.

In Fig. 4 index of texture figures have been set out to show the textural distribution of soils in Barbados according to the suggested classification of Hardy (18). The uniformity of texture is at once apparent. Except for the Red Sand belt, all the soils examined fall within the "loam" classification. Mechanical analyses of a red, black, and a red sand subsoil are set out in Table XXII.

TABLE XXII.

	Black Soil	Red Soil	Red Sand Soil
Coarse Sand	0.69	1.93	32.41
Fine Sand	6.93	3.86	25.68
Silt	1.22	4.08	2.06
Clay	76.34	75.34	17.02
Moisture	11.00	12.00	2.79
Carbonates	4.51	1.33	18.36
Loss in Solution	1.03	1.26	0.90
	101.52	99.80	99.22

It is evident that the red and black soils on the coral limestone formation contain a very high percentage of clay. The excellent texture which is maintained in these soils is, without doubt, due to the fact that they are fully saturated with lime. The red sand soils contain nearly 60% of coarse and fine sand and, in the field, have all the characteristics of sandy soils which contain an excess of calcium carbonate. They are very active, recover quickly from heavy rain, suffer in dry weather and decompose organic matter rapidly.

2. LIME STATUS.

All the soils which have so far been examined have contained reserves of calcium carbonate and have ranged in reaction from about pH. 7.6—8.5. No soil has yet been examined which has possessed an acid reaction. This means that addition of lime or limestone to these soils can have no chemical benefit.

Arrhenius (19) has recently shown in Java that the sugar cane flourishes best under neutral soil conditions and the further the soil reaction departs from neutrality either in the acid or alkaline direction, the more is the yield reduced. Additions of lime to Barbados soils will tend to make the soil conditions more alkaline and would therefore be expected to decrease the yield of cane rather than increase it.

It would seem that on the majority of soils no physical benefit will result from the addition of calcareous matter. It is possible that textural improvements might be effected on the heaviest soils, but such improvements can best be brought about by increasing the content of organic matter together with adequate tillage.

3. ORGANIC MATTER.

The soil conditions in Barbados are highly favourable to the rapid decomposition of organic matter. The trash of the sugar cane when turned into the soil loses all traces of its original structure in from 6—8 months. On most plantations the trash from the cane is the chief supplier of organic matter and the trash is either turned directly into the soil in its original condition or is partially decomposed in the pen and applied as pen manure. It is generally observed by experienced planters that the supply of trash from the present day seedling cane is much less than was obtained from the old Bourbon cane and, in consequence, the soil is less well supplied with organic matter than formerly. These observations are supported by the fact that nearly all soils examined have had low humus contents. This matter is of considerable importance under Barbados conditions where the main limiting factor to growth is water. It is considered that the reserves of humus in most soils need building up if fertility is to be maintained.

The method suggested for increasing the supplies of organic matter on the plantation is to systematically manure the sour-grass pastures. As shown by the manurial trials described in Section III. this practice will increase the sour-grass yield by three to four hundred per cent. As previously recommended, this sour-grass should be used to mulch the young cane during the dry season and, after fulfilling this useful purpose, it will be in a suitable condition to turn into the soil and so increase the stock of humus.

4. TOTAL NITROGEN.

The determinations of total nitrogen which have been made on samples of arable soil are of considerable interest in view of the general practice of heavy pen manuring which is common in Barbados. The distribution of nitrogen in 174 soils representative of the red and black coral limestone and the Scotland soils has been set out in Fig. 5. It is evident that most soils fall within the limits of 0.12—0.20% nitrogen which corresponds to between 2,400 lbs. and 4,000 lbs. nitrogen per acre of surface soil. An average annual dressing of 2 squares or approximately 20 tons pen manure per acre, containing about 190 lbs. nitrogen can be regarded as a very general application to sugar cane in Barbados. Since an average crop of 30 tons sugar cane removes about 43 lb. nitrogen from the soil, there should be an enormous accumulation of nitrogen in these arable soils because sugar cane has been treated in this way in Barbados for a hundred years or more. It is evident, however, that the same loss of nitrogen is taking place from these soils as from the continuous dunged plot on Broadbalk Field at Rothamsted. This observation provides additional evidence to show that the practice of manuring with heavy dressings of dung can not be an economical proceeding.

5. "AVAILABLE" PHOSPHATES.

As the result of the investigations reported on last year, the available phosphates have been estimated from the amount of phosphoric acid soluble in water.

The analyses which have been carried out indicate that the black soils are well supplied with phosphates. The red soils contain little or no water soluble phosphate. The manurial trials which have been carried out on red soils do not, however, indicate that the sugar cane responds to phosphatic manuring and, for this reason, phosphates are not recommended for sugar cane at the present time.

6 "AVAILABLE" POTASH.

The available potash has been determined in the soil samples by leaching with normal ammonium chloride solution and the exchangeable potash is estimated by the volumetric cobalti-chloride method.

The amounts of available potash in the soils examined are very variable and serve as good indices of the previous potash manuring of the fields. Some fields have shown marked deficiencies whilst others show sufficiently high re-

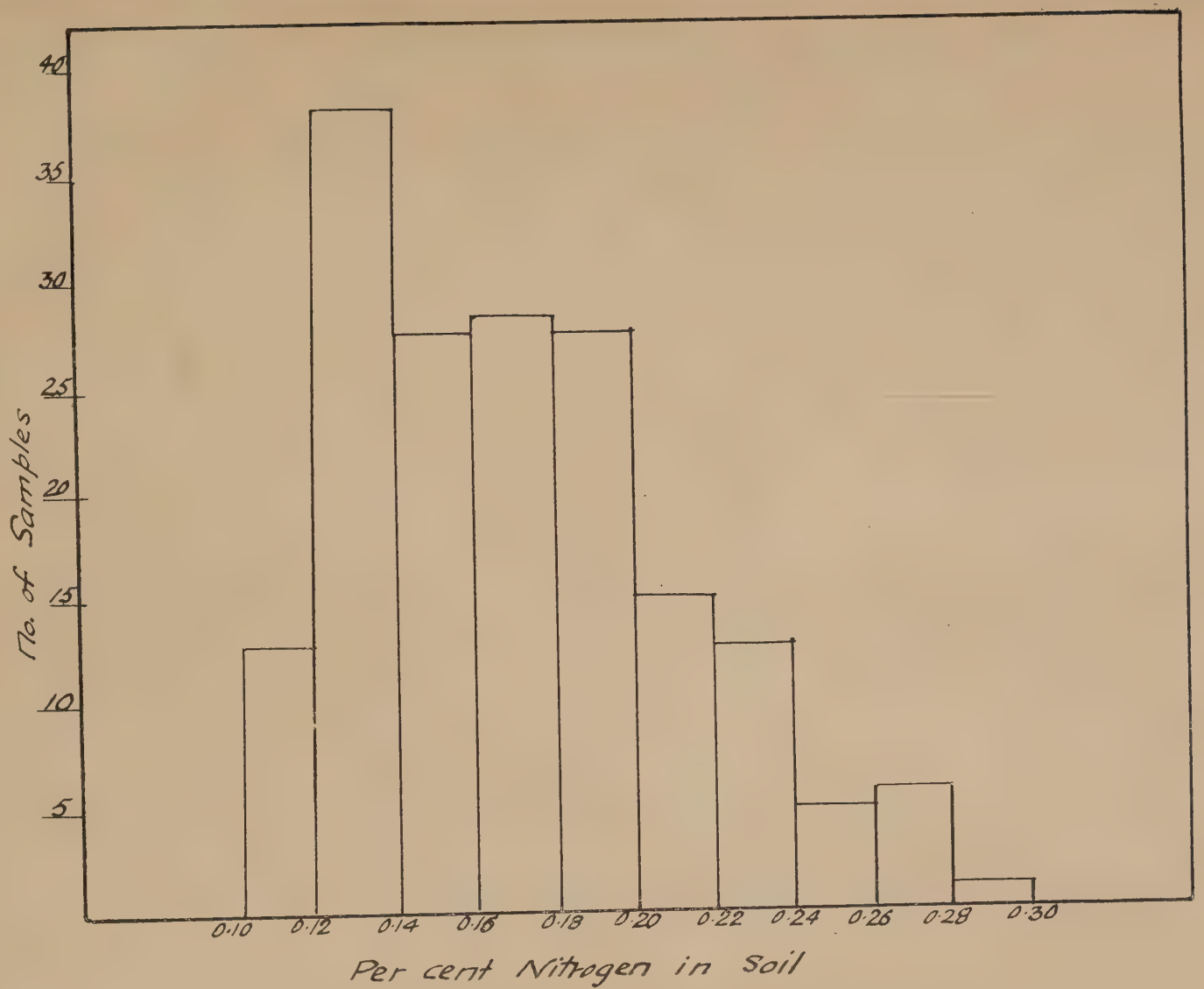
40
35
30
25
20
15
10
5
No. of Samples
0·10
0·12
0·14
0·16
0·18
0·20
0·22
0·24
0·26
0·28
0·30
Per cent Nitrogen in Soil

FIG 6

serves to enable recommendations to be made that potash manuring could be profitably omitted for a year or two.

The question of an approximate limiting value for exchangeable potash upon which to base such recommendations was answered by plotting the result of the exchangeable potash figures against yield. These figures were obtained for the variety trial plots and have been plotted in Fig. 6. Data for the years 1928, 1929 and 1930 are shown. If it is assumed (a) that a yield of 28 tons or more of sugar cane per acre could not be obtained without sufficient potash in the soil and (b) that no other factors limiting the yield of cane affect this data, it is seen that if the percentage of exchangeable potash in the soil is less than 0.014%, the yield of cane is less than 28 tons in 18 out of 31 cases. If the exchangeable potash in the soil is greater than 0.014% then the yield of cane is 28 tons or more per acre in 54 out of 72 cases.

It is, of course, obvious that it is impossible to assume that in the cases under consideration no other factors but potash are affecting yield or that the "exchangeable" potash is an exact indication of the potash available to the plant, so that the deductions to be made from Fig. 6 can only be taken as an approximate indication of the limiting value for potash. It would seem, however that the value of .014% for the limiting value of exchangeable potash has some justification.

It is interesting to note that at the red soil centre (see Table XV) where the manurial trial showed definite evidence of a potash deficiency in the soil, the exchangeable potashes in four soil samples which were taken over the plots were:—

(1) 0.0134
(2) 0.0101
(3) 0.0067
(4) 0.0116

At the black soil centre where the manurial trial showed no response to potash manuring the exchangeable potashes in two soil samples taken over the plots were

(1) 0.0159
(2) 0.0181

These figures offer some support to the conclusion which is being acted upon at present in soil advisory work and which was deduced from Fig. 6 that soils with an exchangeable potash of less than 0.014% need more than the usual application of potash, whilst soils containing more than 0.014% exchangeable potash need less than the normal application. If the soil contains more than 0.02% exchangeable potash, it is recommended that potash manuring can be omitted for a year.

7. RATIO OF ALUMINA TO SILICA.

The clay fractions from two typical black subsoils, a red subsoil and a red sand subsoil were separated and analysed for alumina, iron and silica. The analyses together with the silica/alumina ratios (molecular) are given in Table XXIII.

TABLE XXIII.

Soil Type.	Formation.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	Molecular Ratio Silica/Alumina.
Red ..	Coral Limestone	37.88	28.97	8.47	2.32
Black ..	„ „	40.31	25.62	8.79	2.68
Black ..	„ „	40.69	25.62	9.10	2.70
Red Sand ..	„ „	36.41	24.16	9.90	2.56

These analyses indicate that the coral limestone soils of Barbados cannot be described either as "laterites" or lateritic" according to the definitions of Martin and Doyne (20). It is evident that laterisation has taken place to a much less extent in Barbados than in Sierra Leone.

In this connection it is of interest to calculate out the silica/alumina molecular ratio for the clay fraction of four types of West Indian soils which Hardy (21) has described and used in certain investigations. The types are described as follows:

Type I. *Soils derived from volcanic rocks of hypersthene-andesitic origin.*
(a) Montserrat (b) Antigua, Barbados (Scotland district).

Type 2. *Soils overlying sedimentry calcareo-siliceous clays.*
Antigua.

Type 3. *Soils overlying sedimentary siliceous non-calcareous clays.*
Antigua.

Type 4. *Red lateritic soils.*
(a) Dominica (b) Barbuda, Barbados.

The chemical analyses of these clays as given by Hardy and the calculated silica/alumina ratios are given in Table XXIV.

TABLE XXIV.

	SiO_2	Al_2O_3	Fe_2O_3	Molecular Ratio Silica/Alumina.
Type 1	55.7	15.8	17.7	6.01
Type 2	57.9	17.0	9.6	5.79
Type 3	55.8	23.0	8.2	4.12
Type 4 a	34.6	28.0	21.6	2.10
Type 4 b	39.9	25.7	18.2	2.64

If the definitions of Martin and Doyne are adopted it would appear that no West Indian soils so far investigated could be termed "laterites" or "lateritic." The red soils of Dominica and Barbados most nearly approach the "lateritic" type.

8. SOIL ADVISORY VISITS.

The soil work has necessarily to be concentrated in the "out of crop" season since it is only at this period of the year that time and the necessary assistance are available to undertake the analytical work entailed.

During the year under review, twenty-four plantations have been visited, and usually between three and five fields are sampled; the selection of the soils is left in the hands of the manager. At the laboratory, determinations are made on each sample of the index of texture, loss on ignition, alkali soluble humus, total nitrogen, carbonates, pH., water soluble phosphates and exchangeable potash. As a result of the analyses, an advisory report containing the analyses, an interpretation of the figures and recommendations is sent out.

SECTION V.

THE NUTRITIVE VALUE OF GREEN CROPS WITH PARTICULAR REFERENCE TO SOUR GRASS (*Andropogon pertusus*) WITH NOTES ON THE FEEDING OF WORKING OXEN.

Land which is too shallow for cane cultivation in Barbados is generally planted with sour-grass. Many of these so-called pastures have been in existence for fifty or more years, and the grass is cut once or twice per year. In the "out

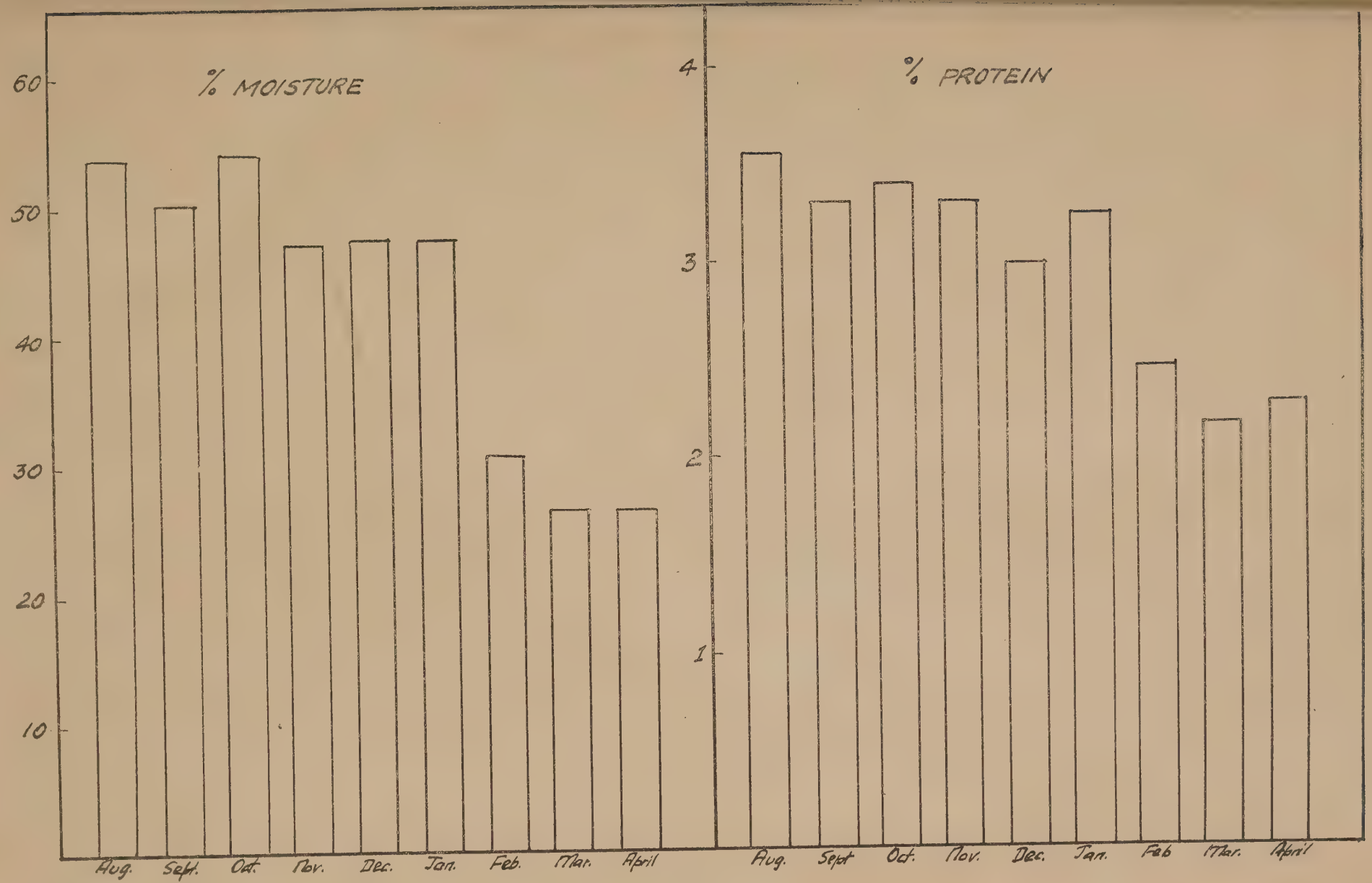
% MOISTURE
60
50
40
30
20
10
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
April
% PROTEIN
4
3
2
1
Aug.
Sept
Oct.
Nov.
Dec.
Jan.
Feb
Mar.
April

FIG. 7

of crop'' season when sugar cane tops are unavailable sour-grass comprises the principal forage for feeding to stock.

During the past year a number of experiments have been undertaken with a view to ascertaining the effects of manuring and time of cutting on the composition and feeding value of sour-grass.

1. *The Effect of Manuring on Composition.*

Samples of grass cut from the manured sour-grass plots at the red and black soil centres (see Section III.) were brought to the laboratory for analysis. In the case of Plots 2 and 3, duplicate samples of grass were taken from different replicates of the similarly treated plots. The results of the analyses are set out in Table XXV.

On the whole, the sour-grass from the manured plots shows a slight increase in the protein content of the dry matter. In view, however, of the differences in the analyses of duplicate samples from similarly treated plots, these differences cannot be regarded as significant with any degree of confidence.

It is evident, however, from a consideration of the composition of the dry matter of sour grass that it is a poor fodder, and manuring will not improve its feeding value to any extent.

2. *The Effect of Time of Cutting on Composition.*

During the dry season from January or February until June or July, the sour-grass pastures turn brown and little or no growth takes place. As soon as the rains commence the sour-grass recommences to grow and green shoots are sent up. Owing to lack of other forage crops, the sour-grass is often cut after the crop season ends in May, and cutting continues throughout the year. The analyses set out in Table XXVI. show the composition of sour grass cut in different months from two centres. These analyses were undertaken in connection with certain experiments of the Veterinary Officer.

The monthly variations in the mean percentage of moisture and the percentage of protein in the dry matter of the sour-grass for both centres are featured in Fig. 7. Examination of these diagrams indicates that the drying up of the sour-grass during the dry season is accompanied by a decrease in the protein content of the dry matter.

TABLE XXV.

1. *Black Soil Centre.*

Composition of Green Fodder.

Treatment.	Date cut	Moisture	Protein.	Oil.	Soluble Carbohydrates	Fibre	Ash.
No Manure.	18.9.29	52.88	1.89	1.27	23.40	16.59	3 46
1½ cwt N, +2½ cwt. P. A	,,	55.17	1.87	1 22	22,86	16.13	2.73
+1 cwt. K. B	,,	54.11	2.23	1.18	22.86	16 69	2.93
2 tons M +1 cwt. N. A	,,	58.20	1.88	1.12	21 51	14.59	2.70
+ 2 cwt P. B	,,	54.67	2.09	1.42	23.81	15.22	2.79
1½ cwt N. +2½ cwt. P.	,,	58.78	2.10	1.34	20·73	14.39	2.66

Composition of Dry Matter.

	Protein	Oil	Soluble Carbohydrates.	Fibre.	Ash.
No Manure	4.02	2.70	50.72	35.21	7.35
1½ cwt. N. +2½ cwt. P. +1 cwt. K. A	4.18	2.72	51.00	35.97	6.13
B	4.85	2.57	49.81	36.38	6.39
2 tons M. +1 cwt. N. + 2 cwt. P. A	4.51	2.67	51.47	34.90	6.45
B	4.60	3.14	52 51	33.59	6.16
1½ cwt. N. + 2½ cwt. P.	5 09	3.25	50.29	34.92	6 45

2. *Red Soil Centre.*

Composition of Green Fodder.

	Date cut	Moisture	Protein.	Oil.	Soluble Carbohydrates	Fibre.	Ash.
No Manure.	2.10.29	59 66	1.94	1.15	20.77	13.05	3 45
1½ cwt. N. +2½ cwt. P A	,,	60.38	2.10	1.10	18.95	14.75	2.72
+ 1 cwt. K. B	,,	61.73	2.21	1.20	17.18	15.07	2 61
2 tons M. + 1 cwt. N. A	,,	58 94	1.87	1.04	20.35	15.11	2 69
+ 2 cwt P. B	,,	59.32	2.09	1 12	19.00	16 00	2.47
1½ cwt N. + 2 cwt. P.	,,	63.78	1.93	1.01	16 23	14.77	2.28

Composition of Dry Matter.

	Protein.	Oil.	Soluble Carbohydrates.	Fibre.	Ash.
No Manure.	4.82	2.85	51.50	32.32	8.51
1½ cwt N. +2½ cwt. P. +1 cwt. K. A	5.29	2.78	47,84	37.22	6 87
B	5.77	3.13	44.90	39.38	6.82
2 tons M. + 1 cwt. N. + 2 cwt. P. A	4.56	2.54	49.55	36.80	6.55
B	5.13	2.76	46.70	39 34	6.07
1½ cwt. N. + 2½ cwt. P.	5.33	2.80	44.82	40.78	6 27

TABLE XXVI.

Composition of Green Fodder.

Centre.	Date cut.	Moisture.	Protein.	Oil.	Soluble Carbohydrates.	Fibre.	Ash.
Well House ...	30.8.29	51.38	1.95	1 12	23.01	16.89	5.68
Well House ..	30.8.29	55.71	1.46	1.06	20.82	16.00	4.95
Waterford ...	11.9 29	50.07	1.28	1.30	26.31	16.69	4.35
Well House ...	30.9.29	49.60	2.07	1.65	25.46	16.11	5.11
Waterford ...	8.10.29	56.15	1.51	1.32	21.45	15.89	3.68
Waterford ...	8.10.29	66.44	1.14	1·10	16.42	11.66	3.24
Well House ...	31.10·29	43.87	1.94	1.45	28.57	18.68	5.49
Waterford ...	8.11.29	47.90	2.13	1.43	26.37	17.20	4.97
Waterford ...	8.11.29	41.94	2.19	1.31	26.63	22.62	5.31
Well House ..	30.11 29	49.16	1.40	1.48	25.91	18.73	3.32
Waterford ...	14.12.29	49.71	1 30	1.01	27.56	15.80	4.62
Well House ...	16 12.29	48.44	2.09	1.35	24.94	16.75	6.43
Well House ...	16.12.29	43 90	1.56	1.37	28.03	18.77	6.37
Waterford ...	7.1.30	57.38	1.54	1 19	21.83	13.68	4 38
Well House ...	16.1.30	39.49	1.79	1.90	25.25	23.70	7.87
Well House ..	12 2 30	30 56	1.87	2.03	35.63	22.26	7.65
Well House ...	12.2 30	30.72	1.61	1.74	33.94	23 95	8.04
Waterford ...	3.3.30	30.07	1.77	1.87	35.74	22.75	7.80
Waterford ...	3.3 30	27.74	1.52	1.76	35.48	26.34	7.16
Well House ...	8.3.30	24.02	1.59	2.14	37.01	26.29	8 95
Well House ...	6.4 30	25.43	1.89	2.38	39.38	22 69	8.23
Waterford ...	12 4.30	28 08	1 55	1.88	38.98	22.54	6,97

TABLE XXVI.

Composition of Dry Matter.

Centre.	Date cut.	Protein.	Oil.	Soluble Carbohydrates.	Fibre.	Ash.
Well House	30.8.29	4 01	2.30	47.33	34 74	11.63
Well House	30.8.29	3.30	2.38	47.00	36.12	11.19
Waterford	11.9 29	2 56	2.60	52.79	33.34	8.71
Well House	30 9 29	4.10	3 28	50.52	31.97	10.13
Waterford	3.10.29	3 44	3.01	48.91	36.25	8.39
Waterford	8.10 29	3.40	3.28	48.93	34.75	9.64
Well House	31.10.29	3.45	2 59	50.90	33.28	9.78
Waterford	8 11.29	4.08	2.75	50.62	33.01	9.54
Waterford	8 11.29	3.78	2.26	45.87	38.95	9.14
Well House	30.11.29	2 75	2 91	50.97	36.84	6.53
Waterford	14.11.29	2.58	2.01	54.80	31.43	9.18
Well House	16.12.29	4.06	2.62	48 37	32.48	12.47
Well House	16.12.29	2.78	2.45	49.96	33.46	11.35
Waterford	7.1.30	3.63	2 79	51.20	32.08	10.30
Well House	16.1.30	2.96	3.15	41.72	39.17	13.00
Well House	12.2 30	2.69	2.92	51.31	32 05	11.03
Well House	12.2.30	2.32	2.51	48.99	34.57	11.61
Waterford	3.3.30	2.53	2.68	51.11	32.53	11.15
Waterford	3.3.30	2 11	2.44	49.11	36.46	9.88
Well House	8.3.30	2.10	2.81	48.71	34.60	11.78
Well House	6.4.30	2.54	3.19	52.80	30.43	11 04
Waterford	12 4.30	2.15	2 61	54.20	31.31	9.70

3. THE AVERAGE COMPOSITION OF SOUR GRASS.

From a consideration of all the various analyses of sour-grass so far undertaken, the average composition of sour-grass cut during the wet season and during the dry season of the year can now be stated with a fair degree of accuracy. In Table XXVII the composition of average sour-grass at these two seasons of the year and, for the purpose of comparison, the composition of average English pasture grass and oat straw have been set out.

TABLE XXVII.

Composition of Green Fodder.

	Moisture.	Protein.	Oil.	Soluble Carbohydrates.	Crude Fibre	Ash.
Sour Grass in Wet Season ..	52.8	1.8	1.3	23.6	16 5	4 0
Sour Grass in Dry Season ..	28.1	1.7	2.0	36.6	23.8	7.8
English Pasture Grass ...	80.0	3.5	0.8	9.7	4.0	2 0
Oat Straw ...	14 0	2.9	1.9	42 4	33.9	4.9

Composition of Dry Matter.

	Protein.	Oil.	Soluble Carbohydrates.	Fibre.	Ash.
Sour Grass in Wet Season ...	3.8	2 7	50.0	35.0	8.5
Sour Grass in Dry Season ..	2.4	2.8	50.9	33.1	10.8
English Pasture Grass	17.5	4.0	48.5	20.0	10.0
Oat Straw	3.4	2.2	49.3	39.4	5.7

The figures given in this Table show up very clearly the poor quality of sour grass as a fodder. The dry matter of average English pasture grass contains four and a half times as much protein and considerably less fibre than the dry matter of sour grass. The composition of the dry matter of sour grass is only slightly better than that of oat straw.

4. THE COMPOSITION OF LEGUMINOUS CATCH CROPS.

Analyses have been undertaken of certain leguminous catch crops which were grown in connection with the green manuring experiments of the Geneticist. The composition of these crops is set out in Table XXVIII.

TABLE XXVIII.

Composition of Green Fodder.

Crop.	Moisture.	Protein.	Oil.	Soluble Carbohydrates.	Fibre.	Ash.
Styzolobium	90.3	1.9	0.3	3 3	3.5	0.7
Crotalaria	86.8	3.2	0.4	4.5	4.2	0.9
Phaseolus Mungo	90.6	2.0	0.3	3.0	3.0	1.1
Melilotus	87.0	1.4	0.3	5.2	5.0	1.1
Dolichus	87.2	2.8	0.4	6.6	5.7	1.8
Canavalia	82.7	3 3	0.4	5.7	5.2	2.7

Composition of Dry Matter.

	Protein.	Oil	Soluble Carbohydrates.	Fibre.	Ash.
Styzolobium —	19.3	2 8	34.0	36.2	7.7
Crotalaria	24.2	3.0	34.2	31.8	6 8
Phaseolus Mungo	21 3	3.2	31.9	31.9	11.7
Melilotus	10.8	2.3	40.0	38.5	8.4
Dolichus	16.2	2 3	38 2	32.9	10 4
Canavalia	19 1	2.3	32.9	30.1	15 6

Consideration of the composition of the dry matter of these fodders shows that they are almost all of high protein value and would make ideal complimentary foods for feeding in conjunction with sour-grass. The field experiments carried out on these crops indicate that *Styzolobium* (the Velvet or Bengal Bean) is a good germinator and yielder giving 5–10 tons of green fodder per acre. It is probably the best of the leguminous crops which have been so far investigated.

5. *The feeding of working oxen.*

Enquiries have been made at a number of plantations as to the general method of feeding working oxen. Four typical daily plantation rations for the "out of crop" season are given below analysed to show cost and content of starch equivalent and protein. During this period of the year the oxen are undertaking light to medium work.

The starch and protein equivalent of sour-grass have been calculated from the average composition given in Table XXVII. for the wet season analysis. The method of Kellner has been used and the digestibility coefficients have been taken from the digestibility coefficients of similar fodders.

TABLE XXIX.

	S. E.	Protein.	Cts.	Cost Cts.
Plantation I.				
50 lb. Sour Grass	6.80	0.35	..	6.00
1.4 lb. Linseed Cake Meal (Oilmeal)	1.11	0.35	4.48	
6.0 lb. V.P. Molasses ..	3.06	0.16	1.98	6.46
	10.97	0.86	..	12.46
Plantation II.				
50 lb. Sour Grass	6.80	0.35	..	6.00
1.0 lb. Linseed Cake Meal (Oilmeal)	0.74	0.25	3.20	
9 lb. V. P. Molasses ..	4.59	0.24	2.97	6.17
	12.13	0.84	..	12.17
Plantation III.				
50 lb. Sour Grass	6.80	0.35	..	6.00
0.5 lb. Iinseed Cake Meal (Oilmeal)	0.37	0.13	1.60	
1.0 lb. Cotton Seed Meal ..	0.42	0.17	2.15	
7.0 lb. V. P. Molasses ..	3.57	0.18	2.31	6.06
	11.16	0.83	..	12.06
Plantation IV.				
50 lb. Sour Grass	6.80	0.35	..	6.00
1 lb. Linseed Cake Meal (Oilmeal)	0.74	0.25	3.20	
1 lb. Soya Bean Meal ..	0.64	0.38	3.50	
1 lb. Corn Meal	0.81	0.07	2.60	
7 lb. V. P. Molasses	3.57	0.18	2.31	11.61
	12.56	1.23	..	17.61

According to the feeding standards of Kellner, the requirements of a draught ox of 800 lb. live weight on light to medium work will be from 8 – 9 lb. starch equivalent containing from 0.9 – 1.1 lb. protein per day.

Examination of the average plantation ration indicates that an excessive amount of starch equivalent is fed, but that, in general, the protein is definitely on the low side. It is evident that the low protein content of the ration is due to the poor quality of the grass. The planter realises that in order to keep his stock in condition it is necessary to supplement the feeding of sour-grass with concentrates. It is recognised on most plantations that the high cost of the stock bill is one of the items which increases the cost of production of sugar cane in Barbados. Any method which would reduce the cost of feeding the stock is therefore worthy of attention.

The method which is suggested in this section is to alter the composition of the roughage fed to the animals. This can be done by the growing of leguminous crops, such as Styzolobium, on as much "thrown out" land and land in preparation as possible. This land is normally idle but by cropping as suggested, not only will a green crop of high protein content be available but the land will be improved by the introduction of a leguminous crop into the rotation.

100 lb. of green Styzolobium of the composition given in Table XXVIII. will have an approximate starch equivalent of 4.7 lb. and a protein equivalent of 1.0 lb. The sample of Styzolobium analysed contained over 90% of water, that is, it contained about one-fifth of the dry matter of sour-grass.

An ox on the plantation eats about 50 lb. sour-grass per day. 20 lb. of this grass could be substituted by 100 lb. green Styzolobium which would contain the same amount of dry matter. Such a ration would contain:—

	S.E.	Protein
100 lb. green Styzolobium	4.7	1.0
30 lb. sour-grass	4.1	0.2
	8.8	1.2

A daily ration such as this would be well balanced and contain sufficient nutrients for a working ox performing light to medium work. It is not possible to give any accurate costs of such a ration at present but it can be confidently stated that such a ration would represent very considerable savings over those in general use to-day.

In applying this system to practice it must be remembered that the Styzolobium will not be ready for cutting until September. In order to have fodder available at all times of the year, it would be necessary to convert much of the Styzolobium-sour-grass mixture into silage. In this way a valuable fodder crop would be available directly after the crop season in May and June when normally no fodder except dried up sour-grass and trash are available for feeding. It is considered that ensilage in Barbados should become part of the routine plantation practice.

SECTION VI. GENERAL ANALYTICAL WORK.

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Chief Analytical Assistant.

Under this head, 992 samples were dealt with. This represents an increase of 269 samples over 1928. They comprise

(*a*) *Police Department.*

Viscera and examinations for poisons, etc.	24
Milks	245
Counterfeit coins and exhibits	32
Tea and cocoa	27
Rum	37
Miscellaneous foods	24

Fourteen grains of arsenic as Rough-on-Rats were separated from six samples of viscera. Three exhibits relating to above visceras were found to contain 2½ oz. of Rough-on-Rats.

A quantity of cooked food was found to contain 32 grains white arsenic. Vomit procured in connection with above gave ¼ grain white arsenic.

A sample of vomit submitted contained 6⅓ grains white phosphorus derived from Steiner's vermin paste. Utensils used in connection with above were also found to contain large quantities of the phosphorus paste.

The contents of the stomach of a cow were examined but showed no evidence of the presence of poisonous substances. In eight samples no evidence of poisonous substances could be found.

Five samples of clothing were submitted for examination for corrosive fluids. In one case the fluid was concentrated Nitric acid—in the other concentrated Sulphuric acid.

All coins submitted were counterfeit. Twenty-eight exhibits in connection with counterfeiting were submitted.

The percentage adulteration of samples of local milk supply was 11.5 as against 17.1 for 1928. The number of samples submitted showed a slight increase over 1928.

Twenty samples of tea (so-called Tea dusts) were submitted. Nineteen were found adulterated and unfit for human food. The chief adulterants were quantities of fine quartz sand and iron filings.

Seven samples of cocoa were submitted; five samples were deficient in cocoa fat.

Of the samples of rum submitted—51% were below legal strength.

The miscellaneous foods include Butter, Lard, Cotton Seed Oil, Bread, Pepper. Only one sample butter was found adulterated.

(*b*) *Customs Department.*

Condensed milks	4
Petroleum	132
Miscellaneous	5

All samples of condensed milk were up to standard of English regulations. All petroleum examined were within the limits prescribed by Petroleum Act.

The miscellaneous samples include spirituous liquors for assay of alcoholic content. Samples of mineral and wood naphtha used as denaturants were also submitted.

(*c*) *Department of Science and Agriculture.*

Fertilizers	7
Feeding stuffs	59
Waters	12

Fertilizers were examined in connection with manurial trials. The feeding stuffs comprise a large variety of fodders, etc., analysed in connection with the work of the Agricultural Chemist.

(*d*) *Waterworks Department.*

Waters	9
Fuel Oil	2

Quarterly analyses of water supplied by the Department from its mains were made as well as samples from Bowmanston, College, Cole's Cave, Newcastle and Belle. The usual uniform high quality was maintained.

Analyses were made and calorific values determined of the fuel oil supplied to the pumping stations.

(*e*) *Analytical Committee.*

Fertilizers	41
Feeding stuffs	60
Sugars and Molasses	14

Samples of fertilizers and feeding stuffs were submitted under Fertilizers and Feeding stuffs Act. A good quality of both products was found.

Sugars and molasses were submitted for analysis and report in connection with prizes at Annual Industrial Exhibition.

(*f*) *Miscellaneous* (*Official*). 70

The miscellaneous analyses and investigations carried out include:

(1) Examination and report on samples submitted by sanitary authorities. One sample condensed milk and 2 samples salted fish were found unfit for food.

(2) Quarterly analyses of waters at Mental Hospital—a high quality was maintained.

(3) Analyses and examinations of genuine samples of tea, cocoa, butter, lard, cotton seed oil, bread and pepper. The contents of a number of genuine samples of these foods were ascertained.

(4) An investigation of the quality of gasolene on the local market was made. A number of samples of all grades were obtained from all garages in Bridgetown. In no case was there any appreciable adulteration with kerosene, and the quality compared favourably with samples of previous years.

(5) The glucose estimation by potentiometer (reported in Chemistry and Industry Vol. 48, 1929) was investigated, and the method adopted for glucose estimation in the Laboratory.

(6) Determination of calorific value of the local coal gas. Results indicate the maintenance of a quality slightly higher than that of 1928.

(g) *Unofficial samples.*

Fertilizers and Feeding Stuffs ..	35
Sryups and molasses	17
Cane juices	55
Spirituous liquors	12
Tea and cocoa	20
Miscellaneous	49

The miscellaneous items under this head include—milks, waters for domestic and manufacturing purposes, limes, hydrometers for calibration, fuel and petroleum oils, etc., etc.

SECTION VII. THE ANALYSIS OF SUGARS AND SYRUPS.

All the sugar and syrup sent in to Bridgetown from the factories is sampled and the samples are sent to the laboratory for analysis. This work is mainly concentrated in the months from February–June. In 1929 when this work was first taken over by the Government a total of 36,402 samples were analysed comprising 30,576 samples of sugar and 5,826 samples of syrup. This year, 1930, a total of 37,282 samples have been analysed to date (31st July) consisting of 27,263 samples of sugar and 10,019 samples of syrup. A consideration of the figures for 1929 and 1930 indicate that more syrup and less sugar were manufactured this year.

Since this laboratory was required to be organised and run as a commercial undertaking, particulars of expenditure and revenue are given. The total expenditure on the personnel, upkeep and equipment of this laboratory since Dec. 1928 has been £1,717. The income received from analytical fees has been £3,684, leaving a profit to the Government of £1,967.

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Chapter IV.

ENTOMOLOGY.

REPORT OF THE ENTOMOLOGIST.

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ENTOMOLOGY.

REPORT OF THE ENTOMOLOGIST.

(R. W. E. TUCKER, M.A., B.Ed.)

SECTION I. INTRODUCTION.

The work carried out during the year July 1929, to June 1930, is a continuation and amplification of that detailed in the 1928-29 Report. The mass breeding and liberation of *Trichogramma minutum,* Riley to control the cane moth borer *Diatraea saccharalis* Fabr. was maintained, and the results set out below leave very little doubt that in Barbados a satisfactory control is being established and that the larger liberation of parasites planned for 1930-31 onwards open up the possibility of practically complete control. At the same time, no other methods of control are being neglected, and the fuller attempt is being made at the time of writing to establish the Tachinid parasite *Lixophaga diatraea* Tsnd. obtained from Cuba through Dr. Myers, Entomologist in the West Indies to the Empire Marketing Board.

The control of cane root borer *Diaprepes abbreviatus* Linn. was carried out according to plan; a large measure of co-operation was obtained from planters and there is every hope that the beneficial results which planters have observed for themselves will result in a still more complete and extensive campaign against this pest in the 1930 growing season.

The control of Pink Bollworm of cotton, *Pectinophora gossypiella,* Saund. was so far successful that at the time of writing no Pink Bollworm has been found by officers of the Department or reported by growers in the crop just harvested. Other factors may have entered into this apparent complete control, but if so, they are at present unknown.

Other entomological work was as detailed below.

The thanks of the Entomologist are due to the various members of the staff of the Department through whose co-operation the amount of work detailed below was possible; especially to the Geneticist, Dr. A. E. S. McIntosh, who carried out a long series of observations on the effect of moth borer on the mortality of young cane shoots in the field; to Mr. C. C. Corbin, Botanical Assistant, who has ably assisted in the mass breeding of *Trichogramma* and Mr. C. B. Foster, First Field Assistant, who has carried out the factory and field estimates of *Diatraea* prevalence and damage.

SECTION II. CANE MOTH BORER.

Diatraea saccharalis, Fabr.

Control by Mass Liberation of Trichogramma minutum, Riley.

A preliminary account of this work has been published in "Tropical Agriculture," Vol VI., No. 8, and a full account of the past season's work is in preparation. The following account will only outline the work done and results obtained in 1929-30.

BREEDING OPERATIONS.

These were carried out on an extended scale towards the end of 1929, and a total of 26,076,200 were bred: of these 22,816,700 were liberated. An eightfold reproduction of parasites is now steadily maintained. Mass production was interfered with by the presence of corn pests and parasites of the host moth *Sitotroga cerealella,* Oliv. which gained access through defects in the first two moth breeding units constructed. The most serious of these pests were the Gamasid mite *Seius* sp. the corn moth *Ephestia kuhnellia* Zel. and the Pteromalid *Habrocytus cerealellae,* Ashm., which is a primary parasite of the host moth *Sitotroga.* The Gamasid mite was controlled by dusting the corn in the units with

sulphur; *Ephestia* and *Habrocytus* were controlled by hand crushing and periodic fumigation with hydrocyanic acid gas used at a concentration which did not kill the pupae of *Sitotroga*.

To counteract the losses due to these pests, a third moth breeding unit was built in July, 1929, and as a result of the control obtained in 1929, a fourth unit was built in May, 1930.

With these facilities for breeding, a peak production of ten to twelve million parasites a month is anticipated for 1930, and a total liberation of fifty to sixty million parasites for the entire year.

Planters now realise the benefit obtained from the parasite, and with improved methods of distribution, no difficulty is anticipated in placing out the above numbers of parasites in regular weekly distributions.

Co-incident with the above work, watch was kept on the work being done by the parasites in the field by weekly collections of *Diatraea* eggs from canefields. These collections were standardised as detailed in the fuller report and served to show both prevalence and monthly incidence of *Diatraea* and the extent of parasitism by *Trichogramma*. Results are given below.

At the time of crop reaping, counts were made of many thousands of canes at various factories over the Island, to ascertain the extent of borer damage. Standardised field estimates were also made of the *total* loss of cane due to *Diatraea*, and finally counts were made of bored and unbored joints of 100 lb. samples each of unbored, slightly bored and badly bored canes taken from each factory. The bored and unbored joints were cut separately at their respective nodes, and all joints showing the internal entrance or passage therein of a borer, were counted as bored though there were no external indications of damage. The bored, slightly bored and unbored joints were then milled separately and the juices analysed. The results thus furnished a fair estimate of damage and loss due to *Diatraea*.

At the same time a standard was obtained for comparison of *Diatraea* prevalence in 1929 and 1930 and for the results which it is hoped to obtain in the 1931 crop by the 1930 liberation of *Trichogramma*.

Space does not permit a detailed account of the figures obtained above. A summary of the more important results following the 1929 liberation of parasites is as follows.

Parasitism of Diatraea Eggs in the Field.

The average of figures obtained from weekly collections made during September, October and November from the same canefields in 1928 and 1929 shows an average increase in parasitism of 11.1% during this period in 1929. A total of 47,700 *Diatraea* eggs were examined for the 1929 records, which were naturally much more extensive than those of 1928 but which will be parelleled by those of 1930.

Factory Estimates of Prevalence of Diatraea in reaped canes.

Five factories were visited in different parts of the Island in 1929 and in 1930, and counts made of badly bored, slightly bored and unbored canes in random samples taken from plant cane as delivered in each factory yard from various plantations. In 1929 the average of cane badly bored was 55%; in 1930 it was 19%; in 1929, slightly bored cane was 31.2% of the crop; in 1930 it was 53.69%. Unbored cane was 9.5% in 1929 and 27.5% in 1930. These figures show a noticeable reduction in borer. Over 2,500 canes were examined for the 1929 records and over 5,000 for the 1930 records. The average weight of a cane in 1929 was 4.05lb.; in 1930 it was 4.77, an increase of nearly ¾lb. per cane. This however may in part be due to coincident control of root borer, *Diaprepes abbreviatus*.

Field Estimate of Total Loss Due to Diatraea.

In 1929 only one complete field estimate was made and the result showed a total loss (factory loss plus unreapable cane) of 31%. An average of four

estimates in 1930 showed a total loss of 20.85% of the crop, due to lessened borer attack.

Analysis of Juice of Bored and Unbored Joints.

This experiment, for which 900 lb. of cane were used, gave an average of 88.12% purity and 19.66% sucrose in unbored joints and an average of 86.29% purity and 18.39% sucrose in bored joints, thus giving an indication of the factory loss due to borer in cane sent in.

Cost of Mass Liberation of Trichogramma.

Taking the life of the breeding room, etc., as four years, the capital and running costs work out at slightly less than 3d. per acre of sugar cane, irrespective of the number of parasites bred and liberated.

Other Control Measures Against Diatraea.

The rejection of all bored sections of cane when sowing the crop has been advocated by the Department and followed by many of the planters.

Use of Cuban Parasite Lixophaga diatraea, Tsnd.

A consignment of 196 pupae of this Tachinid, which parasitises the larvae of *Diatraea saccharalis* were received from Cuba on May 3rd, from Dr. J. G. Myers. Precautions were taken when hatching the flies to eliminate the hyper-parasite *Trichopria* sp., if present and the flies were liberated as follows. One hundred and twelve flies hatched successfully of which 30 were allowed to go free in a field of young cane known to be fairly heavily infested with *Diatraea* and selected by Dr. Myers on a previous visit. Eighty-two were placed in an open air cage 30′x30′x8′ erected in the cane field over the growing canes, which had been given an additional infestation of *Diatraea* larvae, obtained from "dead hearts" cut from other fields. The parasite is thus being given every possible chance to become established.

SECTION III. CONTROL OF CANE ROOT BORER.

Diaprepes abbreviatus, Linn.

The plan put forward by the Department whereby planters were organized in the Windward and Leeward areas affected by *Diaprepes,* into fairly solid groups pledged to collect the pest, met with a considerable measure of success. Fortnightly records of beetles collected were sent in by the planters, and a total of over *five million beetles* were collected and killed. In view of the fact that co-operation was not complete and that some planters failed to do anything against the pest, sufficient beetles will have escaped to make further co-operative collections necessary

The results of the 1929 collections of beetles have shown that emergence of beetles is not confined to the wet season, though emergence reaches a high peak in July–September, but that there is a steady hatching and emergence of beetles for at least nine months of the year; this is supported by the fact that cane stools dug up and examined at various periods had at their roots grubs of various sizes and ages.

Several cases of fields of young cane being practically destroyed by borer were observed, but on the whole, the damage to cane, particularly that awaiting reaping, was noticeably less this year.

The following measures have been advised as necessary for the proper control of *Diaprepes abbreviatus.*

(1) The speedy digging up of cane stumps and destruction of borer grubs in them;
(2) Ploughing, or adequately opening up cane banks as well as holes, to crush and expose the grubs;
(3) Crop rotation to starve out the grubs;

(4) Collecting the newly emerged beetles from June onwards and finding and destroying egg masses in cane leaf tips.

The first three should be normal plantation cultural measures, and in conjunction with the fourth measure, organized as outlined above, should completely control the beetle within a few years.

SECTION IV. PINK BOLLWORM.

Pectinophora gossypiella, Saund.

Full measures to control this pest have now been in operation during the complete growing season 1929–30, and the results appear entirely satisfactory. At the time of writing, the major portion of the crop has been harvested and no pink bollworm has been reported by growers, nor found by officers of the Department during numerous field examinations of the growing crops. An experimental plot sown during the latter part of the close season, but destroyed before reaching maturity was fairly heavily infested, showing that the bollworm was present practically to the time of planting in 1929.

It is recognised that unknown natural causes may have contributed to the apparent complete disappearance of pink bollworm, but it must be pointed out that they are unknown causes; there was nothing abnormal in winds or climate etc. during the period in question.

There is the possibility that the mass liberations of *Trichogramma* may have contributed to the present disappearance of *Pectinophora,* inasmuch as *Trichogramma* is known to parasites the eggs of *Pectinophora.*

The measures adopted against the pink bollworm were as follows:—

(1) No vessel could bring any other cargo save cotton seed. (N.B. Only sailing vessels bring seed to Barbados).

(2) Such vessels are anchored 200 yards from the shore, in an off-shore wind, and discharge all seed through a Simon's Heater, prior to conveyance to the shore;

(3) The holds of the vessels and all sacks which had contained seed were then heavily fumigated with hydrocyanic acid gas before the vessels proceeded into port to take on cargo;

(4) The close season was extended to September 15, 1929, in order that the crop should mature and boll at a season less favourable to the pest, than when the crop was planted at the usual sowing period in June;

(5) During the close season all wild cotton plants and alternate host plants such as okras were uprooted and destroyed as far as possible throughout the Island;

(6) It was required by law that all cultivated cotton plants should be rooted up and burned and all fields cleared of bolls and cotton trash by June 16th, 1930.

The result of the first year's operation has as stated been exceedingly satisfactory, and there is every hope that the growing of cotton in Barbados will before long be rendered safe from attacks of pink bollworm and that other pests such as Mexican Boll Weevil and Cotton Stainers will continue to be excluded.

Parasites of Pink Bollworm.

A further consignment of *Microbracon kirkpatricki,* Ashm. obtained from the Sudan through the Parasite Laboratory at Farnham Royal had to be diverted to Trinidad owing to the lack of material wherein to rear it at Barbados. Careful attempts by the Empire Cotton Growing Corporation to rear it there, however, were unsuccessful.

Other Pests of Cotton.

The next most serious pests of cotton are the defoliators *Alabama argillacea,* Hubn. and *Feltia* sp. and *Xylomerges* sp. The former is a well known cotton pest, but the latter, which usually defoliate sweet potato fields, were found once in vast numbers defoliating cotton. The remedy at present advised in Barbados is dusting with Paris Green and lime, the dilution advised depending on intensity of attack, method of applying dust, and wind, which is usually rather

strong. It is the intention of the Department to obtain proper dusting apparatus and dust mixtures so that planters may be able to apply adequate measures at a reasonable cost.

SECTION V. PROVISION CROP PESTS.

Euscepes batatae, Waterh *in Sweet Potatoes.*

A few observations were made this year on the above pest, known locally as the "Scarabee" but a complete study of its life cycle has not yet been possible. Tubers were found attacked to a depth of nine inches under the soil, the intensity of the attack increasing towards soil level. Larval tunnels containing larvae or pupae were found extending a considerable distance up the main stems above soil level, but did not extend into new, young growth. In younger leaf bearing stems, the presence of Scarabee was apparently caused by independent attack from larvae developing from eggs presumably laid on stems or foliage. Larvae were often found at joints in the stems where shoots used for propagating purposes branched off. Such shoots when torn off as is usually done, carried with them, in most cases, a well developed larva. There is thus a probability of "Scarabee" larvae being in the stem, and at the base of cuttings taken from fields of infested potatoes, and such cuttings would undoubtedly maintain, or spread the infestation.

The beetle itself is sluggish, and does not seem likely to spread far by its own flight, but appears likely to cling to the clothing of workers, particularly women, in infested fields, and so be distributed.

The beetles are long lived, and infested fields should not be replanted with potatoes for several seasons. Further, in view of the above facts, cuttings for propagation should never be taken from an infested source and should in any case be carefully examined before planting. This pest is a most serious handicap to the growing and storing of sweet potatoes in Barbados.

Noctuid Larvae.

The larvae of various Noctuids frequently occur in vast numbers in potato fields and entirely defoliate the plants, often ruining the crops. The same recommendations for control apply as to cotton defoliators.

Laphygma frugiperda, S. & A. Earworm of Corn Zea mais.

This pest causes a certain amount of loss in the growing of corn, and attention will be given to its control as time permits and corn is better grown. Control of this pest will also remove its menace to the developing bolls of the cotton crop.

Diatraea sacharalis, F. Cane Moth Borer.

This is also a pest of corn or maize, and often adds to the infestation of sugar cane, owing to prevalent methods of allowing fields of harvested corn to remain and dry out amid cane fields. It is expected that the control of *Diatraea* in sugar cane will also control it in the corn fields.

SECTION VI. FOOD HABITS OF DR. MORRIS BIRD.

Tyrannus dominicensis vorax.

The investigations into the food habits of this bird were completed and the results published in "Tropical Agriculture," Vol. VII No 3. It was found that the bird feeds extensively on pest insects, but that evidence of its destroying parasites or beneficial insects was lacking. Its destruction therefore is not recommended.

SECTION VII. DESTRUCTION OF MONGOOSE.

This pest still remains uncontrolled, but as its destruction is largely a matter of finance, the removal of its indirect, but undoubted, effect on insect pest prevalence, will probably have to remain in abeyance.

SECTION VIII. PUBLICATIONS.

The following articles were published this year:—

Sugar cane Borers—Trop. Agric. Vol. V., No. 8, pp 224-226.
Food Habits of Dr. Morris Bird—Trop. Agric. Vol. VII. , No. 3 pp. 68-69.
Notes on Insect Pests of Sugar Cane for Use in Elementary Schools of Barbados—Dept. Agric. B'dos. Pamphlet No. 3.

Chapter V.

REPORT OF THE PLANT DISEASES INSPECTOR FOR THE YEAR 1929-30.

(D. R. D WILES, D.I.C.T.A.)

SECTION I.—SUGAR CANE MOSAIC DISEASE.

The continued presence of the mosaic disdase of the sugar cane necessitated the constant inspection of the canes throughout the Island for the whole year. Diseased canes were removed throughout the year; this became possible due to having the Mosaic Disease Eradication Act amended to the effect that "diseased stools could be removed at any time during the year."

A Close Season for corn was again proclaimed, in the infected areas mentioned in the Departmental Reports for the years 1927-28, 1928-29, extending from the 16th December, 1929 to 31st March, 1930.

The presence of the mosaic disease of the cane was considerably less during the period under review than any of the other two periods, especially in the tenantries which were included in the infected areas (vide Annual Reports, 1927-28, 1928-29) due, primarily to the supply of healthy cuttings through the Department of Agriculture and also to the absence of corn with its attendant *Aphis maidis*, the insect vector of sugar cane mosaic.

Managers and occupiers were again invited to have the canes from which they desired to cut their plants inspected. Advantage was taken of this and many places outside the infected areas were inspected with the result that the number of diseased stools, if any, have been reduced very considerably. The necessity for this inspection cannot be too fully stressed as it is on this inspection that the absence of infection in the young crop depends.

Cane plants were again supplied to holders of land in the infected areas. Many occupiers, however, in the infected areas were allowed to obtain their plants from their own holdings after they had been inspected by an Officer of the Department. Certificates of Approval were issued in the usual manner to these holders.

Cane plants were distributed from the following places to the different infected areas:—

St. Michael	.. ..	Lears Plantation.
St. James ..	.. ..	Bennetts „
St. Peter ..	.. ..	Ridgeway „
St. Lucy ..	.. ..	„ „
Christ Church	.. ..	Coverley „

The plants were obtained from fields on the abovementioned plantations under the supervision of an Inspector and the fields were under constant observation from the time of planting until immediately before the distribution commenced.

The inspection of the young crop commenced in mid-January 1930 and is being continued until the height of canes renders this work impracticable.

Parish of St. Michael.

The infected areas in this parish, which consist of numerous tenantries and small holdings are gradually improving and many of the occupiers were able to obtain their plants from their own holdings. It is pleasing to record that up to the present no diseased holes have been found in the Belle Tenantry and Welches. The other parts of the infected areas have shown a decided improvement and at present in some tenantries only a few diseased holes, which are scattered about, have been found. The ratoons in the tenantries have shown a decided improvement over last year and in many instances are the only canes to show diseased stools.

Parish of St. James.

The infection in the Proclaimed Infected Areas is very much on the decline and it is hoped that during the later inspections the infection will be so low as to enable several of the tenantries to be removed from the proclaimed areas.

Parish of St. Peter.

The infection in the proclaimed infected areas continues to be on the decline. This is due, no doubt, to many of the occupiers deciding not to keep ratoon crops thereby lessening the infection.

Parish of St. Lucy.

No infection has been recorded during the period under review in the Checker Hall district and this is doubtless due to the excellent manner in which the occupiers co-operated with the Officers of the Department. Cane plants were however again supplied to this district the reason for this supply being mentioned later.

The results of systematic inspection, roguing of diseased stools and the supply of healthy plants through the Department to occupiers of small holdings which commenced in 1927 are now being appreciated. Occupiers are realising that the Department is not trying to prevent them from growing crops but is assisting them to grow crops which are free from mosaic infection.

The co-operation between the owners of small holdings with the Department has been admirable in so much that there were no convictions under the Mosaic Disease Eradication Act for the period under review.

Appended is a comparative table of mosaic disease infection of young canes for the years 1928 and 1929:—

COMPARATIVE TABLE SHOWING ACREAGE INSPECTED AND MOSAIC DISEASE INFECTION FOR THE YEARS 1928 AND 1929.

Parish.	1928.		1929.	
	Acreage inspected.	No. of infected holes.	Acreage inspected.	No. of infected holes.
St. Michael ..	2,184	15,343	3,812	5,221
Christ Church ..	3,064	2,133	3,398¼	452
St. Philip	1,789½	115	2,173¾	3
St. Lucy	617¼	229	692	56
St. Peter	1,762¼	5,724	2,568¼	782
St. James	454¼	793	960½	846
St. Thomas	947	3,490	905¼	1,626
St. Joseph	79	2	383	111
St. George	..	..	433½	1,559
St. John	108	..	7	..
St. Andrew ..	..	..	..	..
Total	11,005¼	27,829	15,333½	10,656

Up to the time of writing, the number of infected holes in the acreage inspected in 1930 is considerably less than in 1929.

SECTION II.—GUMMING DISEASE OF SUGAR CANE.

The presence of the gumming disease of the sugar cane in Barbados was definitely established on October 18th, 1929, when Dr. Briton-Jones, of the Imperial College of Tropical Agriculture, was shown certain fields of cane which had peculiar leaf markings.

At the present time only the leaf markings peculiar to this disease have been noticed and during the crop season several canes were examined for gummy exudation from the cut ends but so far none has been observed.

A quick survey of the Island was carried out and it was found that the disease was confined mainly to the Leeward parishes of the Island, viz St. Lucy, St. Peter and the northern portion of St. James, and that infected canes were to be found on practically every estate irrespective of the variety of cane. The disease was also found to be present in isolated spots in the parishes of St. Philip and St. John.

Due to the outbreak of this disease the Department supplied to the Proclaimed Infected Areas under the Mosaic Disease Eradication Act in St. Lucy and St. Peter plants of the B.374 and B.417 varieties which had been observed to be fairly resistant when growing along side of heavily infected Ba.11569. Up to the time of writing these varieties have remained fairly resistant when compared with the infection present in the Ba.11569 in these areas.

The presence of leaf symptoms of the gumming disease appeared in the young crop, which had been planted in November—December, in January 1930 and at the present time is to be found in the parishes of St. Lucy, St. Peter, St. James and St. Philip.

Experiments are in hand to ascertain the time of spread of this disease and upon what factors the spread depends as well as what varieties are most resistant to it.

SECTION III.—INSPECTIONS UNDER THE COTTON DISEASES PREVENTION ACT, 1928.

The inspection of tenantries etc. for all wild cotton plants was continued and those which were found were destroyed by fire.

The proper cleaning up of those plots which had been planted to maintain the seed supply for 1929-30 was supervised so as to ensure the effectiveness of the sanitation methods outlined by legislation.

The disinfection of imported cotton seed by means of a Simon's Heater erected on a barge was supervised by an Officer of the Department to ensure that the seed was disinfected at the correct temperature thereby destroying any pink bollworm (larvae or pupae) that may have been present. The optimum temperature for this disinfection to take place is about 55°C.

The bags in which the cotton seed arrives are cleaned by hand thereby removing any seed and lint that may have been adhering to them, and are then fumigated in the hold of the ship with Zyklon B. The bags are strung three deep on lines suspended across the ship and three deep along the ceiling and floor of the hold, 1 lb. of Zyklon being used to 1200 cu.ft of space. It has been observed that after the fumigation with Zyklon B, larvae and pupae of the pink boll worm failed to revive and were quite dead. The hatches of the ship remain sealed for 6—8 hours when they are then broken in the presence of an Officer of the Department who issues the required certificate.

During the period under review 22,110 bags of cotton seed were disinfected in the Simon's Heater and 26 ships fumigated.

The young cotton crop was planted in mid September 1929 and a close watch was kept by fortnightly observations for the presence of the pink bollworm. Up to the time the crop was reaped no pink bollworm were observed.

An Okra Close Season extending from the 15th April 1930 to the 31st May 1930 was proclaimed so as to ensure that this host plant of the pink bollworm was absent during the period when it was most likely to be present. This close season only applied to old okra trees and the Department granted permission to owners of young okra plots to keep their trees provided that only young pods were being kept.

Several pods of the Silk Cotton tree were again examined and no pink bollworm found in any. Pods were taken from all parts of the Island.

The Cotton Close Season for 1930 extends from the 16th June to 31st August 1930 throughout the Island with the exception of certain areas in the parishes of St. Lucy and St. Philip where the close season extends from the 16th June to 15th August.

APPENDIX I.

METEOROLOGICAL OBSERVATIONS.

RECORDED AT THE METEOROLOGICAL STATION, CODRINGTON.

Height Above Sea-Level, 181 feet.
Latitude 13°7′ 36″N. *Longoitude 59°35′ 57″W.*

1929. The details are given in Appendix II.

Barometric Pressure.—The records refer to observations made at the hours of 9 a.m. and 3 p.m. only. During the year 1929 the mean pressure corrected for temperature and gravity and reduced to sea-level was at 9 a.m. 29.980 and at 3 p.m. 29.906, the highest recorded being 30.091 at 9 a.m. on February 15th and the lowest 29.704 at 3 p.m. on October 30th. For the ten-year period 1919-28 the average barometric pressure was at 9 a.m. 29.978 and at 3 p.m. 29.902. The highest recorded pressure during the ten-year period was 30.127 inches at 9 a.m. on January 22, 1925, and the lowest recorded pressure was 29.694 inches at 3 p.m. on September 8, 1921.

Temperature.—The daily mean maximum temperature for the year 1929 was 85.2°F. and the daily mean minimum 72.5°F. The maximum extreme for the year was 89.4°F., registered on June 10th, and the minimum was 65.8°F. registered on January 28th. The average daily mean temperature was 78.9°F., the highest monthly range 21.6°F., and the lowest 15.8°F., the mean monthly range being 18.1°F. For the ten-year period 1919-28 the daily mean maximum temperature was 85.3°F., and the daily mean minimum 72.6°F. During the ten-year period the average daily mean temperature was 78.9°F., the maximum extreme was 91.5°F. on August 23rd, 1927, the minimum extreme 63.0°F. on January 25, 1919 and the average monthly range 18.4°F.

Tension of Vapour and Relative Humidity.—The mean tension of vapour for the year 1929 was at 8 a.m. .724 and at 5 p.m. .700. The mean relative humidity was at 8 a.m. 72.3% and at 5 p.m. 69.3%.

Wind.—The daily (24-hour period) mean velocity of the wind during the year 1929 was 10.4 miles an hour. Records were kept of half daily or 12-hour periods from 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m. The maximum velocity for any such 12-hour period was 21.5 miles an hour, recorded between 6 a.m. and 6 p.m. on July 1st and the minimum velocity was 1.7 miles an hour, recorded between 6 p.m. and 6 a.m. on September 7th.

Rainfall.—The rainfall measured at the Government Meteorological Station during the year 1929 amounted to 43.77 inches. Rainfall was recorded on 212 days, the greatest fall being 1.98 inches on November 15th. For the ten-year period 1919-28 the average rainfall was 43.77 inches and the average number of days annually on which rain fell was 176.

Rainfall of the Island.—The total mean rainfall for the year 1929 from 143 stations was 56.03 inches, being 4.71 inches below the average for the sixty years ended December 31, 1928, which was 60.74 inches.

APPENDIX II.

METEOROLOGICAL REPORT FOR 1929.

DEPARTMENT OF AGRICULTURE, BARBADOS.

Height above Sea Level 181 *Feet.*

Months	Barometric Pressure reduced to 32° Fahrenheit Latitude 13° 7′ N., Mean Sea-level and corrected for gravity.					Temperatures °F.									Tension of Vapour			Relative Humidity.			Wind	Rainfall	No. of days on which rain fell
	9 a.m.	3 p.m.	Mean	Highest	Lowest	Maximum Mean	Minimum Mean	Maximum Extreme	Minimum Extreme	Maximum blackened bulb 4ft from ground in vacuo.	Mean for Month	Range for Month	Dew Point 8 a.m.	Dew point 5 p.m.	8 a.m.	5 p.m.	Mean	8 a.m.	5 p.m.	Mean	Velocity, Miles per hour		
January ...	30·005	29·921	29·963	30·063	29·838	82·7	69·3	84·4	65·8	143·5	76 0	18 6	66 1	65 1	·650	·622	·636	72·4	67·8	70·1	11·4	1·58	19
February ..	30·008	29·925	29·966	30·091	29·856	83·3	69·4	85·2	67·0	146·3	76·4	18·2	65·6	64·3	·636	·604	·620	71·4	65·7	68·6	11·3	1·25	15
March ..	30 010	29·933	29·971	30·057	29·877	84·7	69·0	87·6	68·0	149·8	76·9	21·6	65 9	63·9	·640	·595	·618	68·5	60·7	64·6	10·7	·72	12
April ..	30·006	29 928	29·967	30·059	29·866	85·3	72·3	87·6	67·8	148·3	79·0	19 8	66 2	65·2	·647	·626	·637	64·4	62·6	63·5	12.6	·75	7
May ...	30·000	29 932	29·966	30·046	29·880	86·5	74·0	87·8	72·0	150·6	80·3	15·8	68·8	68·1	·706	·690	·698	68·5	66·3	67·4	14·1	1·46	18
June ..	30·001	29·940	29·971	30·039	29·886	87·0	74·1	89·4	71·8	146·1	80·6	17·6	69 8	69·2	·734	·715	·721	68·9	65 8	67 4	12·0	2 55	18
July ..	30·001	29·950	29 978	30·064	29·895	86·1	73·9	88·2	70·0	144·9	80·0	18·2	70·7	69 9	·755	·734	·744	72·0	67·7	69·9	11·5	4·33	17
August ..	30·006	29·900	29·934	30·052	29·801	86·3	74 9	88·2	71·6	147·3	80·6	16·6	71·8	70·9	·783	·757	·770	73·1	70·4	71·8	7·9	5·77	21
September ..	29·967	29·868	29·901	29·980	29·806	86·1	74·6	88·2	71 8	148·3	80·4	16 4	73 5	72·2	·826	·794	·810	78·1	75·2	76·7	6·6	6·55	19
October ..	29 935	29·841	29·881	29·996	29·704	85·9	74·2	88·2	71·8	149·3	80·0	16·4	73·1	71·9	·815	·783	·799	76 6	74·9	75·8	6·3	5·13	17
November ..	29·922	29 832	29 874	30·009	29·728	84·6	73·5	88·2	70·4	144·9	79·1	17·8	72·4	71·8	·797	·783	·790	79 5	79·2	79·4	9·1	11 04	25
December ..	29·916	29 832	29 874	30·009	29·728	84·6	73·5	88·2	70·4	144·9	79·1	17·8	72·4	71·8	·797	·783	·790	79 5	79·2	79·4	9·1	11 04	25
Total .	359·762	358·870	359·315	360·505	357·946	1021·9	870·6	1049·2	832·4	1760·5	946·6	216·8	832 3	820·8	8·684	8 396	8·540	867·1	831·1	849·4	124·9	43·77	212
Average ...	29·980	29·906	29·943	30·042	29·829	85·2	72·5	87·4	69·4	146·7	78·9	18·1	69·1	68·4	·724	·700	·712	72·3	69·3	70·8	10·1		

RAINFALL AT SUGAR CANE EXPERIMENT STATIONS FROM DECEMBER 1928 to MARCH 1930.

Station.	Height above Sea-level in feet.	December 1928		January 1929		February		March		April		May		June		July		August		September		October		November		December		January 1930		February		March		Total.	
		Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days	Inches.	Days.	Inches.	Days	Inches.	Days.	Inches.	Days	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.
Coverley	254	9	4·80	9	2·88	12	1·71	7	·53	6	1·27	13	1·98	12	1·56	16	6·48	18	6·78	17	7·82	14	5·15	15	7·39	17	3·15	16	3·06	4	·50	3	·69	188	55·75
Graeme Hall		13	4·21	10	1·22	12	1·43	6	·22	5	·69	11	1·48	13	1·82	19	4·28	19	6·45	13	6·78	18	5·92	23	8·08	18	3·08	12	1·23	4	·15	1	·19	197	47·51
Waterford	186	15	3·18	17	2·06	10	·75	6	·31	4	·45	11	1·27	11	1·85	14	4·15	17	5·04	17	6·24	16	5·94	23	12·03	18	1·92	16	1·91	8	1·18	2	·09	205	48·18
Warleigh		14	5·44	10	1·47	17	3·38	8	1·04	3	·22	16	3·07	12	2·44	19	8·20	16	7·52	15	13·52	15	7·90	20	13·15	16	3·19	13	2·42	5	1·57	3	·47	202	75·21
Pickerings	71	11	2·55	7	·42	14	2·30	9	·69	1	·08	15	2·12	17	1·90	16	7·13	17	5·97	16	10·80	15	9·72	19	10·86	11	1·55	9	1·15	8	1·73	4	·32	189	59·29
Lears		23	5·94	15	2·45	18	2·19	9	1·33	7	1.00	17	3·73	12	4·43	13	7·80	9	8·27	13	9·82	16	5·05	16	14·81	9	3·02	18	4·15	8	·88	6	·38	209	75·67
Ridgeway		8	4·93	8	2·55	9	3·11	4	1·29	1	·14	11	3·61	13	4·31	16	7·25	10	8·12	13	8·92	11	6·56	15	10·81	10	2·41	13	3·29	4	1·67	2	·26	150	70·63
Lemon Arbor	720	16	4·51	10	1·93	12	2·06	5	·89	6	·79	14	4·71	11	5·73	14	7·56	16	9·19	15	10·46	18	7·81	20	11·16	14	3·77	17	3·00	11	1·27	2	·87	20	75·73
Vaucluse	731	16	4·17	13	1·41	15	2·09	6	·64	8	·60	20	3·32	16	3·87	20	7·22	20	7·98	17	9·13	20	6·28	22	10·99	18	3·57	17	2·99	13	1·10	4	·31	245	65·70
Blackmans		15	5·40	16	2·67	16	3·18	8	1·69	3	1·45	20	5·30	21	6·16	21	7·35	22	9·21	18	10,35	19	10·24	22	12·48	18	3·69	21	4·66	11	1·59	5	·94	259	86·28
Buckden		16	5·55	12	1·76	12	2·91	8	1·31	5	·96	16	3·58	14	3·86	18	8·65	19	9·16	18	11.15	16	6·23	22	12·31	15	3·49	18	3·59	11	1·64	4	·91	224	76·39
Lion Castle		20	4·52	22	2·06	22	4·06	14	1·51	10	1·35	25	4·21	23	6·60	25	9·87	22	11·18	22	11·94	22	6·10	24	13·38	22	4·62	26	4·54	16	2·10	6	1·20	321	89·51
Mt. Milton		21	3·89	21	1·41	17	2·61	9	1·09	7	1.00	26	3·70	21	5·01	22	7·40	21	9·41	19	10·67	20	9·02	23	10·81	17	3·21	21	4·01	14	2·12	5	·74	284	76·19
Warrens .. .		14	5·51	15	2·38	10	2·17	3	·71	5	1·13	13	2·64	13	5·14	16	7·96	17	8.47	17	9·20	14	5·81	19	17·11	16	3·19	12	3·21	7	1·91	4	·68	195	76·35
Clifton Hall		9	3·45	9	1·10	13	1·51	9	·94	5	·72	16	2·76	15	3·12	21	6·93	20	7·58	17	10·17	15	6·90	22	10·56	15	2·27	17	2·92	10	1·52	8	·75	221	63·20
Govt. Industrial Schools ..		15	3·41	12	1·29	10	1·01	5	·27	4	·94	16	2·00	14	3·02	19	5·45	20	5·33	20	6·10	16	3·42	19	6·02	18	2·84	14	1·75	6	·56	1	·13	212	13·84

SUMMARY OF BARBADOS RAINFALL FROM JANUARY TO DECEMBER, 1929.

Name of Station.	No. of Stations.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.		Total.	
		Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches
District 'A'																											
St. Michael																											
Lowlands ...	18	15	1·81	12	1·34	6	·62	5	·72	13	1·89	13	2·78	16	5·75	17	6·61	16	6·89	15	5·47	21	12·05	18	2·79	167	48·72
District 'B'																											
Christ Church																											
Lowlands ..	14	12	2·00	10	1·54	6	·62	5	·95	10	1·84	11	1·90	15	5·76	17	6·45	15	7·98	15	5·39	18	8·42	17	3·16	151	46·01
St. George																											
Highlands ...	8	11	2·22	12	2·42	8	1·36	7	1·04	16	3 82	14	4·79	16	8·33	19	9·63	16	8·56	16	6·69	19	11·85	15	3·85	169	64·56
Lowlands ...	10	13	2·23	10	1·60	5	·70	6	1·28	13	2 36	13	3·04	16	5·88	18	7.30	16	7·32	16	6·41	19	11·02	17	3·29	162	52·43
District 'C'																											
St. Philip																											
Highlands ...	3	10	1·54	9	1·62	5	·41	4	·79	14	2·39	12	3·31	19	5·93	18	6·67	17	8 20	16	5·42	20	6·77	19	3·32	163	46·37
Lowlands ...	20	10	1·25	9	1·30	4	·42	4	·94	12	2·13	11	2·89	16	5·59	17	6·96	16	7·25	13	4 20	18	7·01	15	2·68	145	41·72
St. John																											
Highlands ...	14	11	1·57	11	2·00	6	·74	6	·72	15	3·30	14	4·58	17	7·27	18	8·17	16	9 94	16	7 32	20	9·45	15	3·25	165	58·61
Lowlands ...	2	12	1·17	12	1·56	5	·49	5	·30	12	2·19	9	2·41	14	6·52	18	5·82	17	8 50	13	5·02	18	6·77	12	1 91	147	42·66
District 'D'																											
St Thomas																											
Highlands ...	9	15	1·78	16	3·07	8	1·13	7	·99	18	3·69	17	5 19	20	8 22	19	10 56	18	11·15	19	7·16	21	11·42	17	3·92	195	68·28
Lowlands ...	7	13	1·90	13	2·35	5	78	4	·58	15	3 09	13	3·72	18	7·07	17	7·41	16	8 89	16	6·13	17	11·63	16	3·51	163	57·06
St. James																											
Highlands ...																											
Lowlands ...	8	12	1 74	13	2 34	7	·90	5	·48	16	2·69	15	3·77	17	6·75	15	7·75	14	10·08	15	5·62	20	10·42	17	3·41	167	55·95
District 'E'																											
St. Peter																											
Highlands ...	7	9	1·06	15	3 27	7	·97	4	·35	15	3·35	15	2·68	17	8 30	18	6 73	18	14·02	16	11·04	19	12·95	16	2·86	169	67·58
Lowlands ...	4	14	1·66	19	3·26	9	1·29	5	·39	18	2·65	15	2·79	20	7·13	18	6·60	17	12·14	15	8·00	20	12·70	19	3·38	189	61·39
St. Lucy																											
Lowlands ...	9	6	·67	12	2·53	5	·66	1	·12	13	2·26	12	2·69	16	7·10	16	6·16	16	9·66	14	7·93	18	11·81	11	2 25	140	54·14
District 'F'																											
St. Joseph																											
Highlands ...	6	13	1·92	16	2 94	9	1·39	6	1·03	19	3·96	17	4·20	21	8 73	23	8·13	18	10·84	17	7·28	22	12·18	17	3·40	198	66·00
Lowlands ...	1	12	1·88	11	2·62	3	1·13	2	·44	10	2·81	9	2·36	18	8·91	16	7·01	14	9·85	16	8·12	18	9·63	13	4·02	142	58·78
St. Andrew																											
Highlands ..	2	10	1·08	15	2·67	6	·76	2	·23	15	2·39	12	2·21	19	7·32	20	5·98	18	12 16	17	12·92	23	10·24	18	2·81	175	60 77
Lowlands ..	1	10	1·56	12	2·62	6	·86	3	·27	12	2·57	11	2·02	13	6·74	13	4·50	14	11·96	13	10·43	18	10·05	11	3·33	136	56·91
	113	209	29 04	227	41·05	110	15·23	81	11·62	256	49·38	233	57·33	308	127·60	3 17	127·84	292	175·39	278	130·55	349	186·57	283	57·14	2,943	1008·54
	143	12	1·61	13	2·28	6	·85	4	·65	11	2·74	13	3·19	17	7.09	18	7·10	16	9·74	15	7·25	19	10·35	16	3·18	163	56·03